MACHINE DESIGN

PARTS • MATERIALS • METHODS • FINISHES

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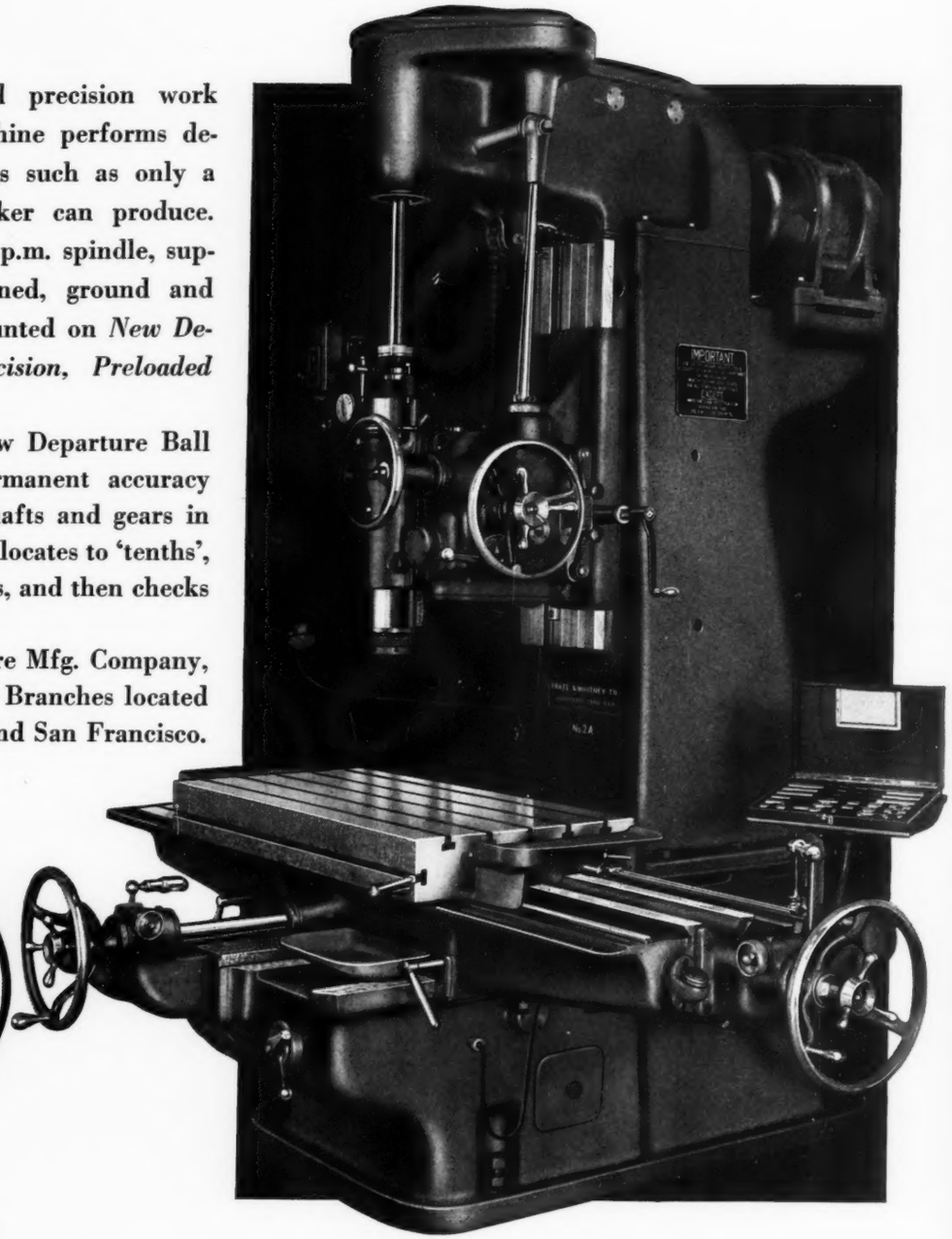

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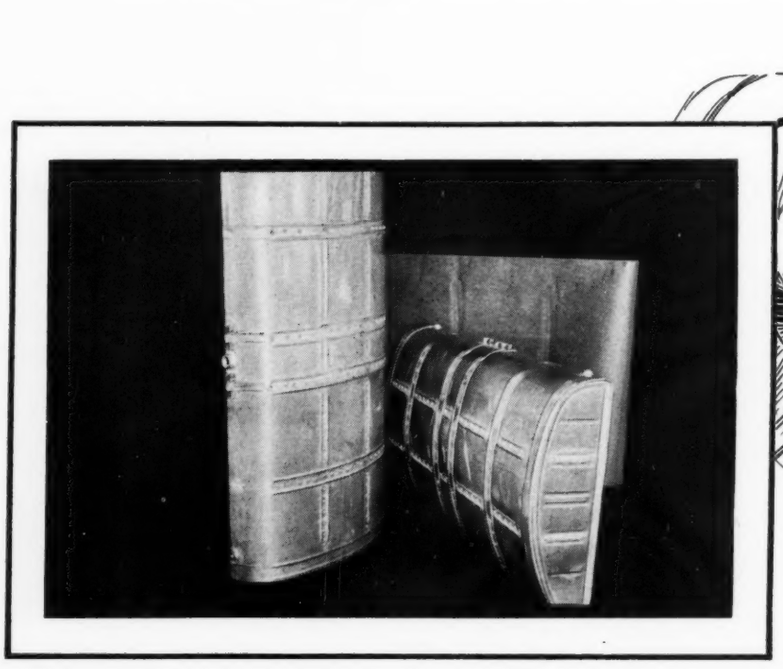

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Topics . . .

ONE of the most interesting problems connected with the development of airplane apparatus has been the overcoming of fog and other natural phenomena which so "blind" a pilot that he cannot determine just where he is. "Rails" have been provided in the air by the perfection of directional compasses and radio beams. With them the pilot can *fly* with absolute accuracy. But if the pilot is unable to put the plane back on the ground, there is not much use in taking off and flying. To permit landing in a fog, use has been made of the Sperry automatic pilot which again has proved its inestimable worth. This gyroscopic device guides the plane along a beam which curves in a vertical plane, flattening out as it nears the ground. Watch for it as part of regular air equipment in the near future.

♦ ♦ ♦

All steps toward the perfection of safety devices do not concern themselves with air transport, however. Automotive designers have been doing everything possible to reduce the appalling number of automobile accidents But there is still the human factor to be considered. One method of reducing the desire for speed is reported from Yugoslavia by the National Safety council. Here the police take the speeder to the side of the road and let the air out of all four tires. If the day were hot, this would make us give up driving permanently.

♦ ♦ ♦

Another sugestion to overcome the tendency for speed has been made by Dr. George H. Stacy of Peoria, Ill., who has taken for his slogan "Best keep the point of the needle out of the red." His idea is to paint that section of the speedometer which shows speeds over fifty miles per hour in red. Speeds of from 0 to 30 would show green, while from 0 to 50 would be yellow.

♦ ♦ ♦

Engineers designing machinery for consumer markets can contribute greatly to the promotion of their machines by giving the prospective consumer a better understanding of the method of operation. General Motors has blazed the trail along these lines by the preparation of a booklet on "What Makes the Wheels Go Round." This most complete exposition tells in simple language, understandable to anyone, just how the various mechanisms in a motor car work. (For the first time, we were able to make "the little lady" understand a differential). A better understanding of the mechanism cannot help but lead to better consumer relations and a desire of the consumer to take better care of the machine he has purchased. Another interesting booklet on these lines prepared by the same company is "Diesel, the Modern Power."

♦ ♦ ♦

Prediction of forthcoming developments is imposible in many lines, but in automotive designs changes are accurately foretold by the type of production equipment purchased, a great deal of which is now being delivered for 1937 models. On this basis, machine tool builders can state with a large degree of certainty that there will be few drastic model changes next year. The shift of Chevrolet to a side valve motor is said to be postponed. There is more doubt about the predicted smaller V-8 of Ford for which some parts are being made, while the proposd diesel passenger car of General Motors will wait until the market is more nearly ready for it.

♦ ♦ ♦

A most cheering development for the design profession is the encouraging advances in railroad equipment which have finally pulled this basic factor in American business into more modern lines. Perfected diesels are now rapidly entering freight lines, while the Burlington has two new Zephyrs running from Chicago to Denver and reducing the

(*Continued on Page* 82)

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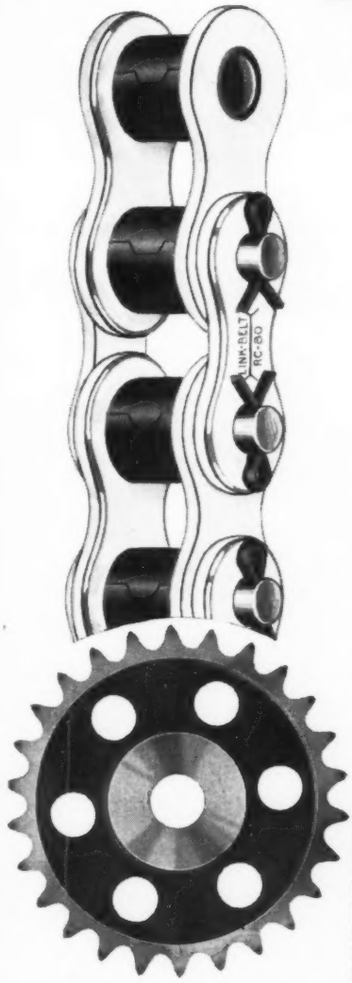

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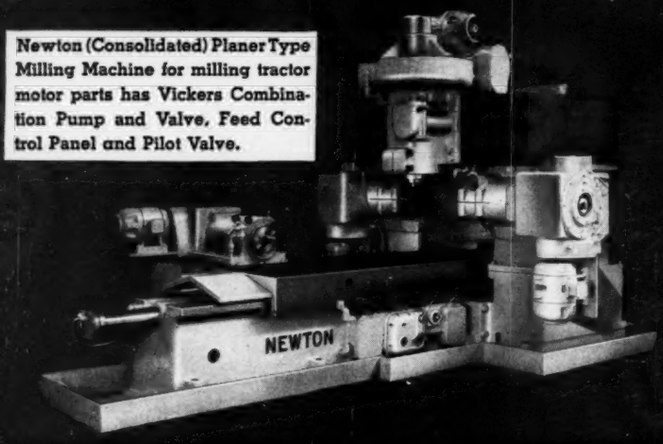

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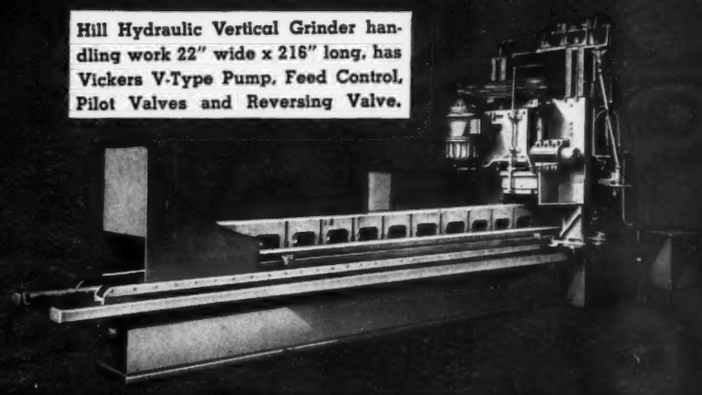

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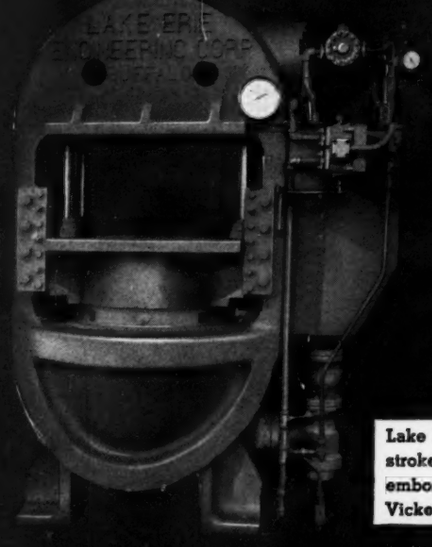

Lake Erie 2000-ton high speed (6 strokes per min.) die sinking and embossing press provided with Vickers Hydraulic Equipment.

Colonial Hydraulic Spiral Broaching Machine having 30 tons capacity and 60" stroke equipped with Vickers Pumps and Controls. Machine is controlled from one pilot valve.

MACHINE DESIGN

Are Your Ideas Patentable?

By George V. Woodling

STRANGELY enough, no one, not even the courts, can positively define what is invention. About the most the courts can say is that the idea or creation must be the product of inventive faculties. But this does not help very much in testing any particular case. An additional factor which adds to the difficulty of defining an invention is that the Patent Office, not infrequently, grants patents which are subsequently found to be lacking in invention. In this case it is the duty of the courts to declare the patent invalid. Therefore, when we speak of a device being *patentable,* or amounting to *invention,* we mean one that is enforcible by the courts, and not one for which the Patent Office has merely granted a patent. This distinction, discussed briefly in the article "Careful Research Obviates Patent Pitfalls," MACHINE DESIGN, March, 1933, will be shown in relation to the patentability of various designs in the following.

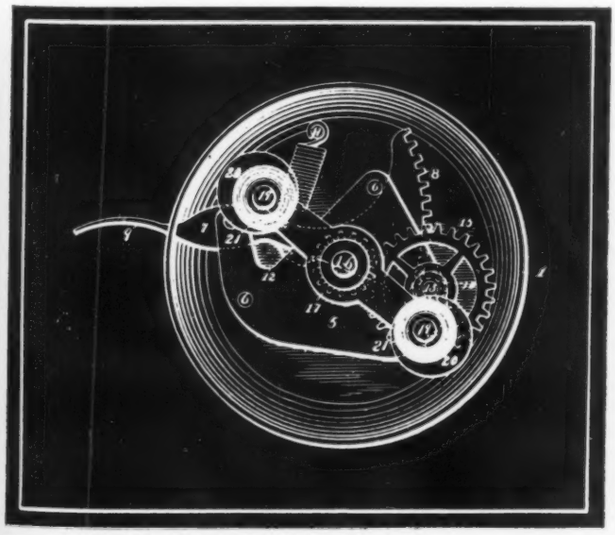

Fig. 1—Mere addition of segmental gear and pinion wheel to this mechanism does not constitute invention

Impossible To Define Invention

Inasmuch as it has been impossible to set up an accurate positive definition of an invention, the courts have established certain "Negative Rules," which specify

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what is *not* invention. Several samples of the most important of these rules will be given in the following to assist the reader in finding the answer as to whether or not his own ideas are patentable.

Mechanical Skill vs. Inventive Skill

Of these "Negative Rules", the one which is probably most generally invoked is: To produce something by mere mechanical skill is not invention. (The term "mechanical skill" in this case is not interpreted by the courts as the skill of the mechanic, but rather is used in the broad, or intellectual sense.) Suppose that the chief

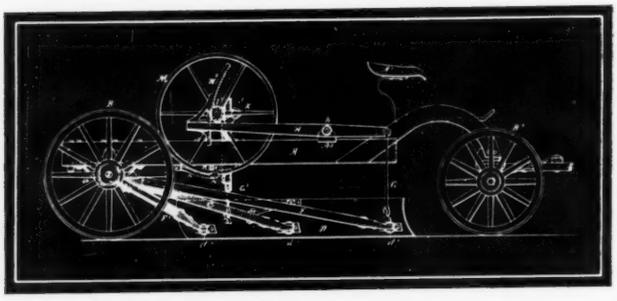


Fig. 2—Increasing the size of a part, such as the handwheels on this machine, is not invention

engineer assigns to one of his assistants the job of improving the construction of a certain device that their company is manufacturing and selling in order to increase its commercial utility. Within a few days, let us assume that the assistant completes the new design and submits it to the chief engineer for approval. In examining the new design the chief engineer finds that while the assistant retained some of the elements of the old machine, he rearranged them in a different manner to produce a design vastly superior to the old one and worthy of meritorious recommendation.

Compare the New with the Old

Now assume that the question arises as to whether or not the new design is patentable. To test this we must compare the new design with the old, as well as with prior patents, to determine whether or not an ordinary person possessing a working knowledge of design matters would have produced the same design as the assistant engineer produced, by the application of mere mechanical skill as distinguished from inventive skill. But difficulty is encountered in applying this test, for the reason that after seeing the new device and comparing it to the old there is a tendency in many cases to belittle the ingenuity involved in producing the new design, and hold it to be the product of mere mechanical skill. "Invention after the fact" always looks easy. The courts are aware of this tendency and thus tend to avoid it. Observe the following extracts which were taken from a court decision, but modified by the writer to make it apply to the above situation.

"The line which separates invention from mechanical skill is at best a narrow one, and the difficulty of demarcation in this case is enhanced by the fact that of necessity we look upon the old device with eyes instructed by the new device, and must take care that we do not in such light so mentally reconstruct the old device as to see in it those possibilities which may seem very obvious now, but which may not have been disclosed by the old device; for, vague and uncertain as may be the line of demarcation between mechanical skill and invention, we could not deny the assistant engineer the right of invention, unless the idea upon which his patent is predicated is so clearly set forth or suggested by the old device that a mechanic, with the old device before him, could by mere mechanical skill so modify proportions or change the mode of operation as to overcome the difficulties which excluded the prior device from commercial utility,"—

Nearly All Employ Same Elements

"It does not follow that the inventive idea is the same because each employed a metallic element and an elastic element to accomplish the same purpose; for, if terms are employed which avoid defining the distinctive character of the device or imperfectly describe it, few patents would escape being declared invalid for nearly all employ the same elements. The imagination may find in the "disk of sheet metal" of the old device, the cup-shaped disk of the new design; for men are prone to see what they want to see. Polonius saw in the cloud first a camel, then a weasel, and then something "very like a whale," as Hamlet bade him. Taught by the new device, we can see that a "disk of sheet metal" may be converted to a purpose altogether different to that which the old device used, not by a mere mechanical change, but by a functional change, which constitutes invention due to a conception of a different plan".—

Aggregation Is Not Invention

An important legal distinction exists between a combination, which is patentable, and an aggregation, which is not. In a combination the assembled parts of a device co-operate to produce a joint function, whereas in an aggregation the assembled parts do not co-operate but operate independently to produce nothing more than the summation of the separate parts. The ordinary lead pencil having an eraser on one end is the classical case of aggregation. The United States Supreme Court held that there is no joint operation performed by the pencil and the rubber. It is interesting to note that inasmuch as the whole is greater than the sum of its parts in a true combination, it violates the theorem in geometry which states that the whole is equal to the sum of its parts. The thing that makes the whole greater than its parts is the *new function* produced by their union. If there is no new result, it is only an aggregation of

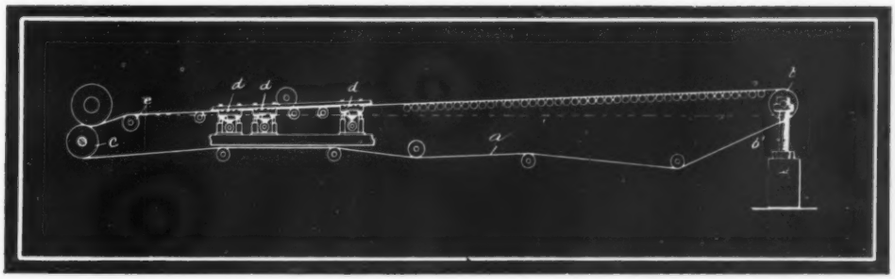


Fig. 3—Elevation of one end of Fourdriner rolls gives the machine a new function

separate elements. A good example of a true combination is a winding stem and bearing mounting for a watch. This combination performs a double duty. In one capacity it winds the watch, and in another capacity it carries the watch upon the chain.

Parts Are Considered Separately

A rather recent case involving the question of aggregation is the grease gun rack, *Fig.* 4, which one sees in many gas stations. As illustrated, the rack relates to a series of grease guns mounted upon supports, and having a series of indicia indicating the part of the automobile to be lubricated. Here, the total function of the entire grease gun assembly is no greater than the summation of the individual parts. In rendering the decision upon this case, the court made the following analogy which appears to be worth while setting forth here.

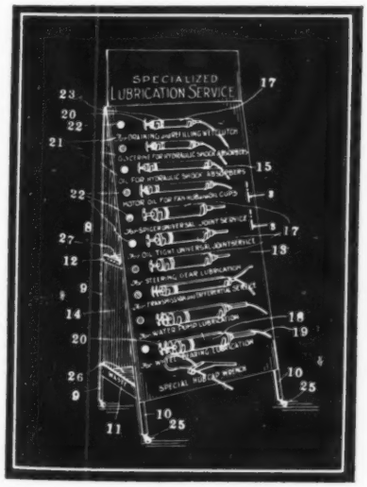


Fig. 4—Aggregation of elements, such as the arrangement of these grease guns, cannot be considered invention as there is no new function produced

"A rough analogy, that cannot be pressed too far, has repeatedly occurred to me in considering this question. I think of a football team as a combination; one passes, one receives, another blocks, another runs, and still others hold the line, eleven men are doing different things, each in his own way, and not always simultaneously; yet they are working to a common end to advance the ball; and they coact as a unit. I think of a track team as an aggregation; one runs, another hurdles, another jumps, another throws, they all work for a common general end, to mass points for their alma mater; but there is lacking the vital spark of co-operation or co-ordination. They work, not as one unit, but as several."

In connection with the question of aggregation versus combination, it is well to bear in mind that it is not necessary for all of the elements of a machine to coact at the same time with each other in order to constitute a true combination. It is sufficient if the elements so coact that as a consequence of their union a new and useful result is obtained.

Adding Extra Parts Is Not Invention

The mere adding of extra parts to a machine is not invention, unless the additional parts produce a new function. A case involving this principle is the bicycle bell shown in *Fig.* 1. This bell is of the general type which is capable of being connected to the handlebar of a bicycle in such manner that only the thumb of the rider is needed to sound the alarm, in which case the rider's grip upon the bar is not materially interfered with when ringing the bell. As illustrated, the striker bar is driven by means of a segmental gear which meshes with a pinion for operating the striker bar when the thumb piece is actuated. A spring is employed to retract the striker bar in the opposite direction. In comparing this bell with the previously used bells, the court found that the precise mechanism was used before, except that the bell shown in *Fig.* 1 merely added the segmental gear and pinion wheel for actuating the striker bar. This did not introduce any new function in the operation of the bell. Therefore the court held that this bell did not constitute invention over prior bells.

Duplication and Omission Considered

Closely associated with the foregoing is another "Negative Rule": namely, To duplicate or to omit one or more parts of a machine, or to change the location, or the reversal of the parts, is not invention, unless a new result is accomplished. An excellent example where a court found a duplication of parts amounted to invention was a case relating to a water-driven propeller upon a vertical shaft. The invention re-

lated to the use of two water propellers, arranged face to face on the same vertical shaft so that the downward vertical thrust caused by one propeller would be counterbalanced by the upward vertical thrust caused by the second propeller. The counterbalancing action relieved the mechanical pressure upon the vertical thrust bearings, and, in analyzing this case, the court found that the duplication of the water propellers caused a new result by relieving the bearing pressure, and upheld the validity of the patent.

Variations in Size Not Patentable

To change the size or degree of a thing, or to increase the speed of operation, or to enlarge and strengthen a machine so that it will operate on larger materials than before, is ordinarily not invention, unless the change produces a new mode of operation. The decision in a case involving the ordinary road grader shown in *Fig.* 2 held that it was not invention to increase the size of the handwheels which were used by the operator in raising and lowering the blade.

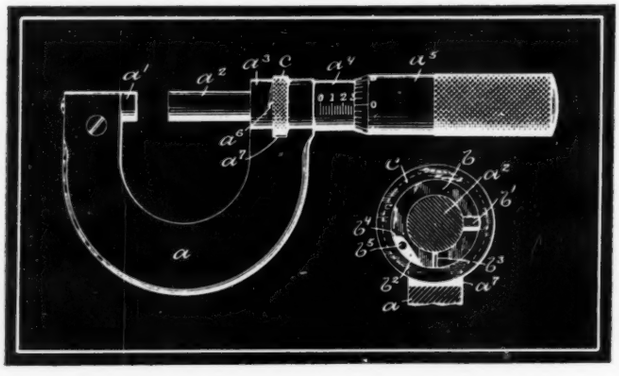


Fig. 5—Application of a clutch in the design of these micrometers provided the basis for a sound patent

Extra Momentum Created

The patentee argued forcibly that the increasing of the weight of the handwheel amounted to invention. He based his argument on the proposition that by making the handwheels heavier the extra momentum carried the wheels along sufficiently to enable the operator to take a new grip, without each time clamping the wheels to prevent their reversing or running backwards. He contended that this produced a new result and amounted to invention. However, the court held otherwise and found that the improved operation was but merely a change in degree. The patent, therefore, was held invalid.

A good illustration where a court held that a change in degree amounted to invention is the case relating to the Fourdrinier machine shown in *Fig.* 3. The main feature of the Fourdrinier machine is an endless wire cloth sieve which passes over a series of rolls at a constant speed and carries the paper stock. This invention related to the elevating of one end of the endless wire cloth and the series of rolls, so that the stock or paper pulp would travel with the aid of gravity much faster than before in the ordinary machines having substantially a level arrangement of the rolls and the endless wire sieve. With this arrangement, the speed of the machine was materially increased to bring the rate of travel of the endless wire sieve up to the speed of the rapidly moving paper stock, caused by gravity resulting from the elevation. As a result, the capacity of the machine was increased from 20 to 30 per cent, and the court found that a new mode of operation was produced. The patent, therefore, was held valid.

It is difficult in cases involving the mere change of degree, or size, of a thing to determine in advance whether or not it is worthwhile to spend a considerable amount of money and file a patent application and attempt to protect the so-called improvement by a patent. The main decision to make in cases of this kind is to determine whether or not a new and unexpected result is accomplished by varying the size or degree of the machine. If you can advance a good argument that a new result is accomplished, it usually is worthwhile to proceed with the protection.

Substituting Equivalents Is Not Invention

To change a device by substituting equivalents for any one of its parts is ordinarily not invention unless a new and unexpected result is obtained. A striking example of how a substitution amounted to invention is a case which relates to the micrometer caliper shown in *Fig.* 5. This invention makes special reference to an improved device for clamping the spindle by means of a clutch so that the spindle is securely held in position without the least possibility of minute disturbances of the adjustment of the spindle. A question arose as to whether or not it was invention to apply a clutch to micrometer. In a suit thereon, the defendant argued that it did not amount to invention on the ground that the idea of applying a clutch to a multiplicity of objects is inherent in the very nature of the clutch. The court found, however, that although the general use of clutches was well known in other arts, the adapting of a clutch to a micrometer constituted invention. The main reason for this holding was based upon the fact that micrometers are used to calibrate differences within less than one-thousandths of an inch, and thus the problem was of a different nature from

(*Concluded on Page* 84)

Scanning the Field . . . FOR IDEAS

HYDRAULIC power is now applied to the driving of engine lathes, in such a manner as to insure at all times proper spindle speed for diameters being turned.

The new drive, which is housed in a special cabinet leg under the headstock, comprises a constant speed electric motor connected to a hydraulic pump, which in turn is connected to a hydraulic variable speed constant horsepower motor through the medium of a forward and reverse valve. This fluid motor is connected by multiple V-belts to a sleeve-mounted sheave pulley which is supported on its own antifriction bearings but which drives the spindle through a system of multiple splines. This arrangement relieves the spindle of belt tension. In cases where a slow range of spindle speeds is necessary, the drive is through a single set of back gears, instead of direct to the spindle. Drives from 5 to 20 horsepower are available with speed ranges to suit the work to be done.

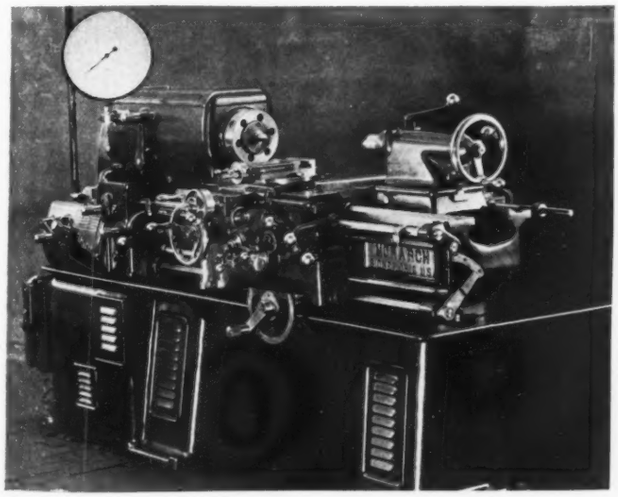


Fig. 1—Variable speed fluid motor insures correct spindle speed for every working diameter

Control of the fluid motor, which gives infinitely variable speeds within wide limits, is either manual through a crank on a segment at the base of the apron, or automatic through gearing and cams operated by the inward or outward movement of the cross slide. With the automatic control, the speed of the spindle adjusts itself to suit different diameters on long work, or to the constantly varying diameter when facing. The machine shown in *Fig.* 1 a Monarch tool room lathe, is arranged for manual control. It is equipped with a tachometer which registers the revolutions per minute of the spindle and also the corresponding surface cutting speeds for various diameters.

DIAPHRAGM REGULATES FEEDING

MANY an involved device has been employed with indifferent success to control the level of material in the bins of packaging machines and similar equipment. It is a control problem which has necessitated considerable study because of the importance of maintaining

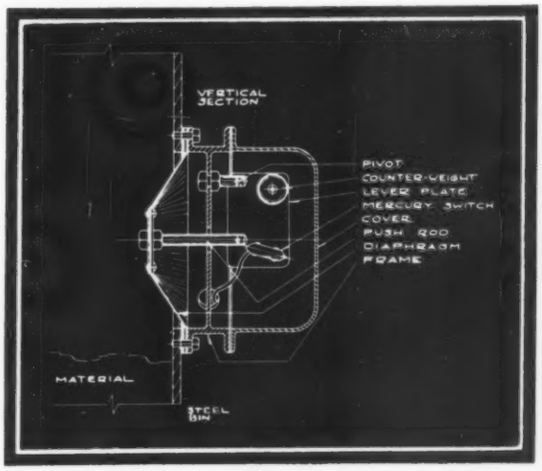


Fig. 2—Bin level is regulated by pressure of material on diaphragm

the level of this material between fixed limits to insure that it will flow out of the bin in an easily regulated stream. Now a principle of operation which further demonstrates the practical use of mercury switches solves this problem.

As is generally known, the tilting of a mercury switch will complete an electrical circuit and start a motor, switch on a signal light, or do any of a number of electrical chores. In the bin level controller developed by Bin-Dicator Co., and shown in *Fig.* 2, this tilting is accomplished by the material itself. As the material rises in the bin, its weight acting against the diaphragm forces in the push rod. This in turn swings the lever plate on its pivot, thereby tilting the mercury switch. Thereupon, the switch either turns off the power of the conveyor bringing in the material, or lights a signal bulb indicating that the conveyor should be stopped manually. When the material level drops below the controller the pressure against the diaphragm is relieved and the counterweight forces the lever plate back to its normal position, reversing the position of the switch and starting the motor.

By varying the counterweight and diaphragm material the unit can be adapted to a wide variety of applications. These units are now operating in connection with wood flour weighing 13 pounds per cubic foot, and on ilmenite ore weighing 182 pounds per cubic foot.

DUAL DRIVE UTILIZES FREE WHEELING

BASKET-TYPE centrifugals require a quick accelerating high speed drive for the "whirling" phase of their cycle but when it comes to "plowing out" during the unloading operation, slow speed with strong pulling power must be provided. To attain both these conditions in a compact and efficient power unit, American Tool & Machine Co. has devised a dual motor system embodying the free-wheeling principle.

Fig. 3—Double motor drive unit for centrifugals utilizes free-wheeling principle

In the unit shown in *Fig.* 3, the main or high speed drive motor is vertical and is direct connected to the basket through a flexible coupling. At the top of this motor and at right angles to it is a smaller motor which comes into action during the slow speed, heavy operation of plowing out the accumulation in the basket. This secondary motor turns the basket through the shaft of the unenergized main motor, to which it is connected by worm and wheel. The free-wheeling device is contained within the worm wheel and permits the main motor when operating under its own power simply to overrun the low speed connection.

CONE GIVES EXACT ANGLE

MATERIAL poured over the apex of a cone distributes itself evenly around the base, regardless of the size and shape of the pieces. Through a modification of this principle, Stock Engineering Co. has developed conical distributor which avoids segregation of material. These patented conical distributors are being used successfully as feeders to stokers of large

Fig. 4—Diagrams from top to bottom visualize steps in design reasoning through which the theory of even spreading of ungraded broken material around the base of a cone was applied. The result is a nonsegregating chute for feeding coal from hopper to grate in boiler furnace stokers

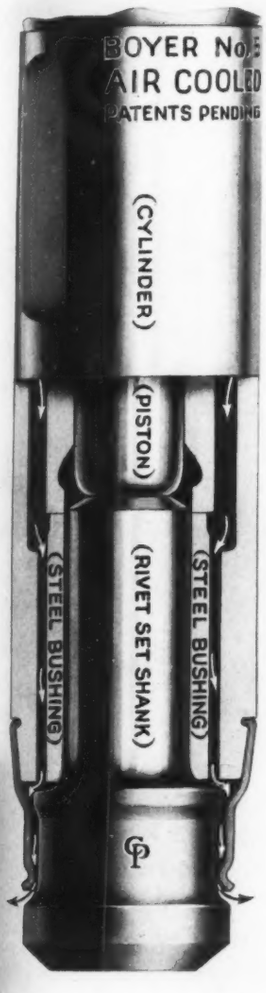


Fig. 5—After driving the piston of this pneumatic hammer, cooling air rushes through ducts in the tool and exhausts around the hot spot at the end of the rivet set, thus keeping heat out of the mechanism and away from the hands of the operator

boiler furnaces, giving even fuel distribution across the entire width of the grate, regardless of the mixture of coal sizes.

Fig. 4 shows the development of the conical feed from theory to practice. The two upper illustrations demonstrate distributing action of a full cone, while the third and fourth show the steps by which the cone has been modified into a non-segregating chute such as used to feed a stoker.

USING EXHAUST FOR COOLING

COMPRESSED air which drives the hammer is made to do double duty in the Chicago Pneumatic tool shown in section in *Fig.* 5. By making use of the exhaust air for cooling purposes, trouble due to transfer of heat from rivet to rivet set and from rivet set to the body of the hammer, is said to be overcome.

Ports in the form of four slots pass down the full length of the cylinder, on through the bushing into which the shank of the rivet set fits and open into the guard around the nose of the rivet set. Exhaust air from above the piston discharges through these slots as indicated by the arrows, being deflected outward around the nose of the rivet set, the hottest spot.

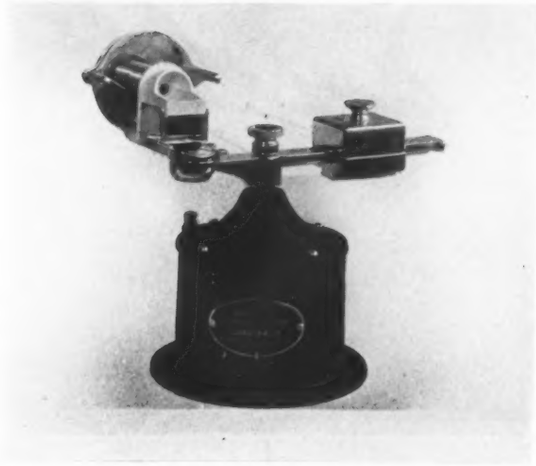


Fig. 6—Centrifugal casting machine harnesses inertia as well as the centrifugal force

WHIRLING MAKES FOR HOMOGENEITY

CENTRIFUGAL casting has proved to be an excellent method of securing both large and small castings of a dense and homogeneous nature. But surprising enough there is danger that one section of the centrifugally cast part will be too dense and that margins will lack sharpness, or, in other words, that homogenity will not be obtained. This is particularly true in work done by jewelers and dentists where hot metal is "slung" into a rotating mold. As the metal starts to flow into the mold, the turning effect is inclined to force it into that side of the mold away from the direction of rotation. That side thereby tends to become denser than the rest of the casting and free flow is impeded.

To overcome this difficulty the impelling force must be made to act in such a manner that the molten metal is forced straight into the mold, and then evenly distributed within the mold, at all stages of the pressure-casting cycle. This is impossible when a straight arm is used to whirl the crucible and mold, but by introducing a hinged elbow into the arm it is accomplished.

Fig. 6 illustrates a spring-driven centrifugal casting machine built on this plan by Detroit Dental Mfg. Co. Its hinged arm is shown positioned as when at rest or when rotating at low speed. Until considerable speed is attained, the outer section of the arm remains in this tangential position, inertia of the molten metal during this time causing it to flow straight back from crucible to mold. Then, as the speed of rotation increases centrifugal force develops to such an extent that the elbow straightens out, whereupon this force comes into action still further to press the metal straight back into the mold.

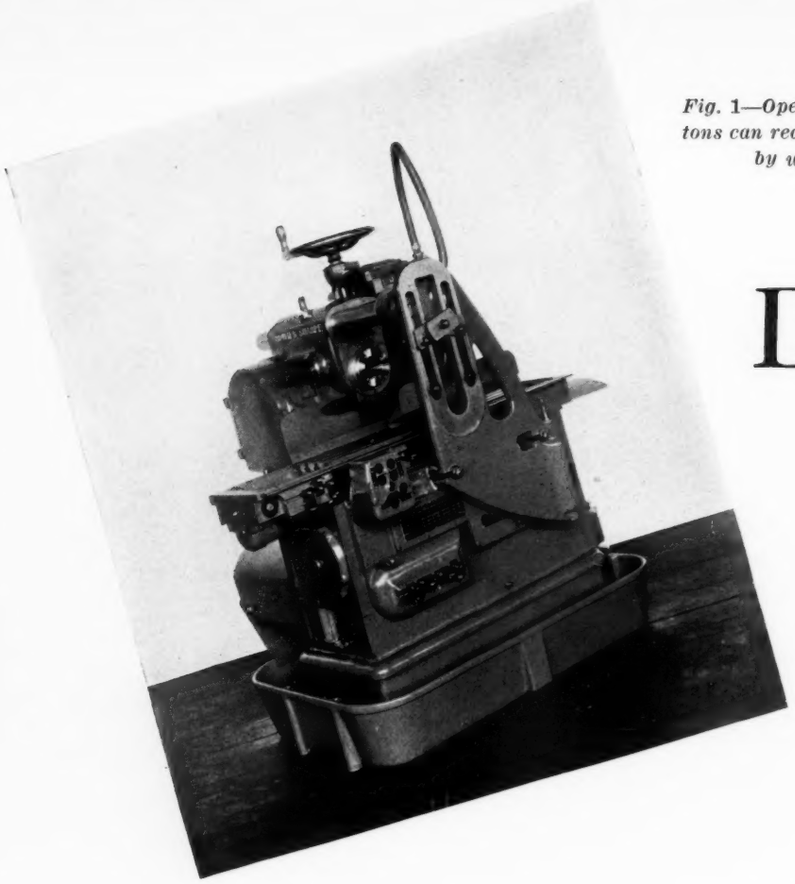


Fig. 1—Operating pushbuttons can readily be reached by workman

Does All-Electric M

Indicate N

MACHINE DESIGN'S "nose for news" led the editor on a recent trip to the Brown & Sharpe Mfg. Co.'s plant. He was deeply impressed by the design features of the new electrically-operated milling machine discussed in the accompanying article, published as a result of interviews with B. P. Graves, director of design, and A. L. Krause, electrical engineer. Designers of almost any type of machine might well study the development and progress exemplified by this outstanding machine tool.

APPLICATION of electrical control to all operating functions of the new No. 12 Brown & Sharpe plain milling machine, *Fig.* 1, has been found to simplify setting up, to increase operating flexibility and to make it possible for this machine to achieve production results which previously were difficult or practically impossible. The electrical controls, which are shown clearly in *Figs.* 1, 5 and 6, are located for easy observation and adjustment. As is indicated by *Figs.* 5 and 6, they can be set for either manual or automatic operation. These controls insure perfect co-ordination of action between table and spindle.

"Climb milling", which ordinarily is a hazardous operation, can be done with safety in this machine because of the fact that a backlash take-up device is provided on the table feed screw. This take-up is released automatically through the medium of a solenoid the instant that rapid traverse of the table is engaged. Table movement is reversed or stopped by controlling the table motor and it is shifted from rapid traverse to feeding speed by a clutch operated by the same solenoid that operates the backlash take-up. These related backlash take-up and table shift mechanisms, which are shown in *Fig.* 3, are described more in detail further on in this article.

Driving power of the new machine is sub-

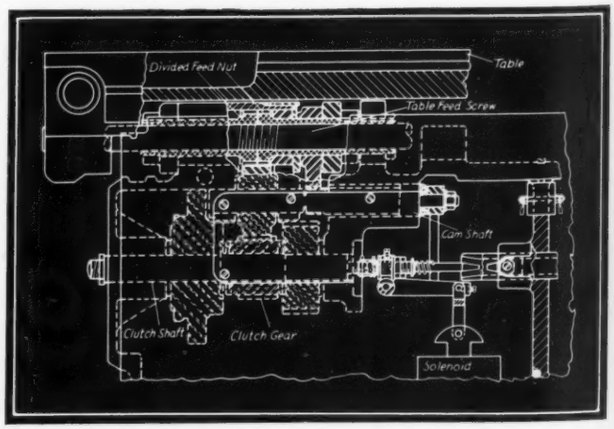
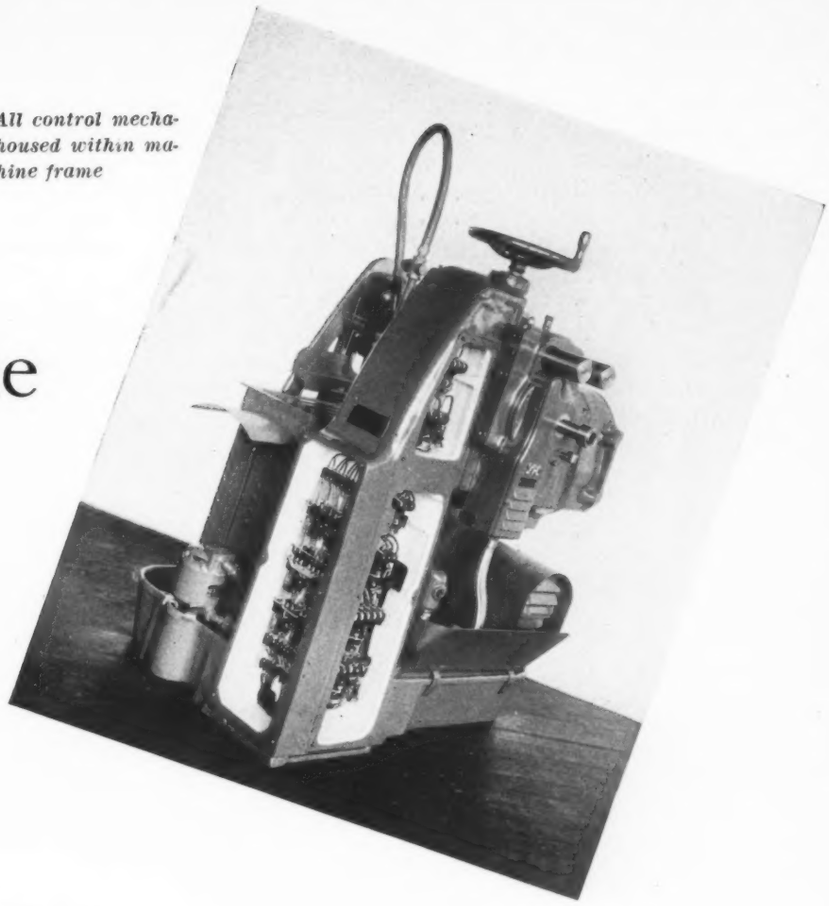


Fig. 3—Solenoid controls changes in table feed and also table back-lash eliminator

Fig. 2—All control mechanism is housed within machine frame



ctri Milling Machine

cate New Trend?

divided electrically. That is, individual motors are provided for the spindle, the table and the coolant pump. The table and spindle motors have to make frequent starts and stops, stopping being accomplished by a form of dynamic braking called "plugging". This means that they are electrically reversed and suddenly brought to rest by the reverse torque thus developed, being electrically disconnected at approximately the instant of zero revolution.

This procedure generates heat in the motors to an amount which is a function of the total stored energy of all the rotating parts. Generally the rotor has the largest portion of the stored energy. Hence it is desirable not only to keep down its speed but also to keep its diameter small. For this reason, reversing motors usually have speeds of 900 or 1200 revolutions per minute. It is a fact, however, that low speed motors are physically larger. This tends not only to make the machine more bulky, but also to wipe out some of the advantage of low speed because of the higher inertia of the rotor.

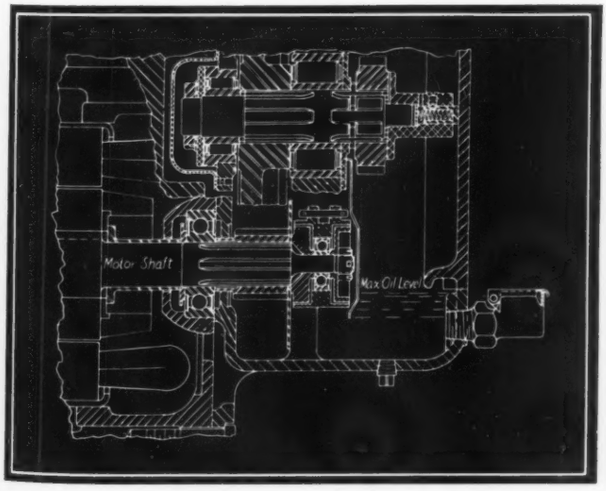


Fig. 4—Cross section of viscosity switch, showing method of mounting on end of motor shaft

Consideration must also be given to the economic side of the question. The price of a higher speed motor generally is considerably less than that of a lower speed motor, although this is not always true when going from 1800 to 3600 revolutions per minute. Larger motors increase the size of a machine, thereby increasing its price. This is true particularly if the motors are of shell type such as are considered in this article.

The shell-type motor shown in *Fig.* 8 originally was developed for use on wood-working machines such as shapers. It consists only of rotor and stator, the shaft, housing, bearings and ventilating system being provided in the design of the machine itself. This type of motor has the disadvantage that it cannot be used in places where only direct current is available. Furthermore, their use is practically impossible

on 25 cycles because of the increase in size which is necessary. However, they provide "a large amount of power in a small package", and they can be built in as an integral part of the machine, giving compact, neat construction. No couplings are required, the motor shaft being merely a continuation of one of the machine shafts, and external wiring is eliminated.

Generally, the motor mounting, being the frame casting of the machine itself, has much greater mass than the ordinary motor frame. This is advantageous in the dissipation of heat. Consequently, the built-in motor can develop greater horsepower than a similar motor mounted in the conventional manner. Tests have proved that the built-in table motor is capable of being reversed approximately 400 per cent more frequently than a motor mounted in an external cradle.

Under the "plugging" system, it is necessary to use a so-called "plugging switch", the purpose of which is to disconnect the motor when it stops. With built-in motors it is possible also to build the plugging switches neatly into the machine. Since the rotating element of the switch control shown in *Fig.* 4 is mounted integral with the motor shaft, troublesome extra bearings are eliminated.

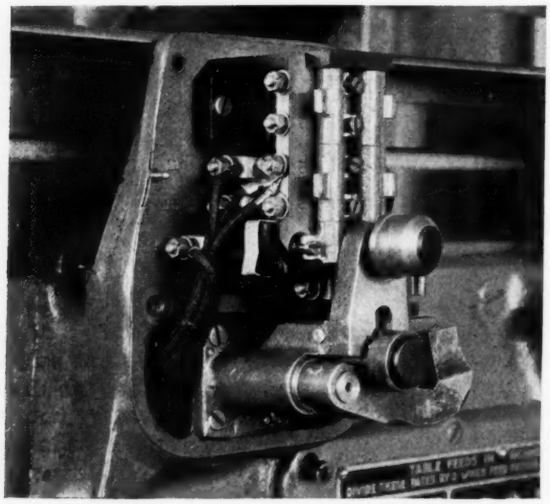


Fig. 5—Central control unit, cover removed

High Speed Motor Acts Quickly

The spindle motor has a rating of 3 horsepower at 3600 revolutions per minute, and the table motor 1 horsepower at 3600 and 1800 revolutions per minute. This two-speed table motor gives dual range of feeds and permits automatic change in cutting speeds to take full advantage of production possibilities. The high motor speed may raise doubts in the mind of some readers as to the ability of the motors to stop and reverse quickly and accurately, inasmuch as it already has been mentioned that such motors are inclined to have a large amount of stored energy. It is a fact, however, that the spindle of the new machine—when geared to run 200 revolutions per minute—comes to a stop within approximately one-third of one revolution of the cutter.

Accuracy of reversal of the table motor is demonstrated by the following test, which has been made repeatedly—using a very slow feed in the slow speed series (that is, with table motor speed of 1800 revolutions per minute) a cut is taken part way into a test block at approximately the full capacity of the spindle motor. During this heavy cut the table motor is reversed by means of one of the table feed dogs. The arc left by the cutter at the termination of this cut is then coated with a film of oil, and the machine is operated again through the same cycle, but without load. In every case the cutter has partially, but not wholly, removed the thin oil film, thereby proving conclusively that the amount of load does not influence the point of reversal.

Control Units Are Combined

The machine is arranged so that it is possible to start the table either in "feed" or in "rapid traverse", in either direction. Furthermore, a change can be made from any one operating condition directly to any other. This requires a "Feed Right", a "Feed Left", a "Fast Right" and "Fast Left" pushbuttons, as well as a "Stop" button, making a total of five pushbutton stations, plus one more for the "Spindle Jog", as shown in *Fig.* 6. Similarly, since the dogs on the table must actuate limit switches to make a similar change in operation automatically, there is required a duplicate set of "Feed" and "Fast Traverse" switches as well as a "Stop Right" and "Stop Left" switch. Thus a total of twelve pushbutton stations and limit switches would be required if standard devices were used. When the size of the standard unit is considered, one can appreciate what it would mean to mount any such number of standard type of pushbutton and limit switches on a small machine. Since the pushbutton and limit switches perform the same function, they can be combined in one unit, *Figs.* 5 and 6.

By developing a special control unit, *Fig.* 2, compact construction has been secured. Where possible, the units are made to serve the dual function of pushbuttons and limit switches. The assembly shown in *Fig.* 2 serves the purpose of six limit switches, six pushbuttons and one safety interlocking switch which electrically disconnects the table motor when the table gearcase is open. This safety switch is located in the lower portion of the circular opening shown at the

Fig. 6—Close-up view of operating pushbuttons and table dogs

right-hand side of *Fig.* 7, the black plunger being pressed in when the door is closed, thereby enabling the starting of the machine.

Many milling applications require a "Spindle Stop". In other words, after completing the cut, but before the work is carried back under the cutter, the spindle must be brought to rest to prevent cutter marks on the work. To accomplish this the spindle must be stopped almost instantly since at the rapid traverse return rate of 300 inches per minute any delay or slowness in stopping would cause the work to be drawn backward under the cutter before the spindle had come to rest.

Originally the spindle was arranged with a solenoid-operated friction brake. This proved to be too slow in action, and it was believed that wear under severe operating conditions would make frequent adjustments necessary. Plugging the motor was tried, but by itself it was not satisfactory, it being difficult to bring a drive to absolute zero speed in this manner when there is but little friction. The plugging switch would disconnect the motor at practically zero speed, but there was nothing to prevent slow continued residual motion. By using a small friction brake in conjunction with plugging, however, it now is possible not only to bring the spindle to rest almost instantly, but also to hold it stationary while changing cutters. The wear on this friction brake is negligible since it is not applied until the motor reaches a very slow speed. In general there are three distinct types of plugging switches. They employ either friction, centrifugal force, or viscous drag to close a contact while the motor is running and then permit the contact to open when the motor stops. Most of these switches were found suitable for use only up to speeds of 1000 revolutions per minute.

As it was desirable to mount the plugging switch directly on the motor shaft running at 3600 revolutions per minute, it was necessary to develop a special unit. A friction switch has disadvantages of heat generation and wear, particularly at high speeds, while the centrifugal type is somewhat complicated. The simplest system is that making use of the viscous drag of an oil film, as this gives a simple, compact unit with no wearing parts. It has the apparent disadvantage that changes in temperature change the viscosity and therefore the stopping point. However, since a friction brake is applied to the spindle after plugging is completed, it actually makes but little difference whether the switch operates at 50 or several hundred revolutions per minute. When it is considered that a decrease in speed from 3600 to 600 revolutions per minute leaves only 3 per cent of the stored energy to be absorbed by the brake, it is obvious that any variation in brake application can be ignored.

Oil Viscosity Activates Switch

The plugging switch developed for the new machine is shown in *Figs.* 4 and 7. In the drawing, *Fig.* 4, it will be seen that a ball bearing is mounted on the motor shaft extension between two flanged disks of aluminum. On the outer race of this bearing is pressed an aluminum shell, a few thousandths clearance being allowed between the bore of this shell and the peripheries of the two disks. This assembly runs in a bath of oil to a depth of about half-inch. The result is that viscous drag tends to revolve the outer shell as the disks rotate within it. When at rest centering springs on the guide rod extending to the left, *Fig.* 7, hold the shell in neutral position with its connecting lugs at top center. A connecting rod from

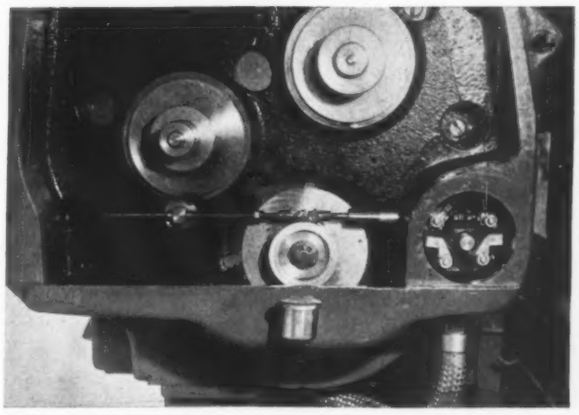


Fig. 7—Viscosity type plugging switch is built onto end of motor shaft

these lugs to the plunger of a double-throw switch at the right completes this plugging switch assembly.

The plugging switch on the feed motor is of similar construction but serves a dual purpose. No brake is used with it, so this switch alone must stop the motor completely. Slight reversal is not objectionable but it must not be allowed to roll the switch control shell from side to side as that would cause the motor to vibrate between forward and reverse. Positive control is attained by a solenoid-operated latch. This drops when the "Stop" button is pressed, thereby preventing the plugging switch from passing through neutral.

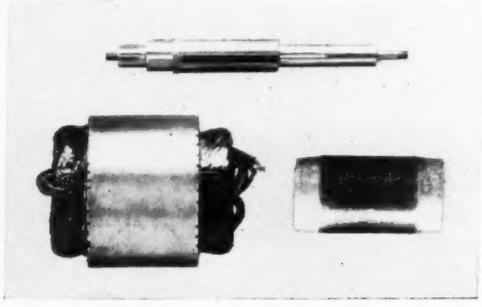


Fig. 8—Individual shell type motors are built into machine

This viscosity switch as it is called also controls the point of shifting when the table motion changes from feed in one direction to fast traverse in the other direction. When feeding into a blind cut, change to fast traverse cannot be made until the table is stopped or starts traveling in the opposite direction. The viscosity switch is a direct means of governing this, additional contacts being provided which do not close until the motor has reached zero speed. These contacts then establish the circuit to a solenoid causing the clutch to shift to fast traverse position.

Backlash Is Eliminated During Cutting

The table backlash take-up mentioned at the beginning of this article and shown in *Fig.* 3, has as its basis a pair of long revolving nuts located end to end on the table feed screw. When these are pressed toward each other as they are when the slow or feeding motion is being imparted to the table, end play between the nuts and the screw is taken up. The moment that the rapid traverse of the table is engaged, the two nuts are caused to separate slightly. This allows a small degree of end play, and the nuts have free fit on the thread which is desirable at the high speed at which they run during this part of the operating cycle.

This backlash eliminator and the shifting mechanism for the table feed are operated by a dual purpose solenoid located in a vertical position below the mechanism. It can be seen in the lower right hand corner of *Fig.* 3. When the armature of this solenoid is pulled down it shifts the lower shaft to the right, thereby engaging the fast traverse clutch which causes the table to travel at 300 feet per minute. At the same time the linkage from the solenoid causes the secondary shaft above the clutch shaft to rotate slightly and a cam on this shaft separates the two feed nuts on the table screw. When cutting is to be done this action is reversed, thus tightening the feed nuts on the screw by squeezing them together.

To secure quiet operation and at the same time obtain maximum power in minimum space, this solenoid is immersed in oil. At first a special grade of oil was used but later it was found that by giving special treatment to the coils regular machine lubricating oil was satisfactory. The increased pull is obtained by using a reduced voltage coil, the extra heat thus generated being readily dissipated by the oil.

The magnetic switch panels, as shown in *Fig.* 2, are all built into the machine column. They are of the solenoid-operated type, the solenoid acting directly to move a cross bar carrying the movable contacts.

Fig. 9—Wiring harness with all wires cut to proper length and numbered

As a protection to the operator, electrical interlocking is provided both on spindle and feed gear change doors. If either of these doors is opened the motors driving the gears are disconnected electrically so that they cannot be started inadvertently while the operator is handling the gears. The arrangement of the safety switch of the table feed can be seen in *Fig.* 7. It is located in the lower part of the circular opening at the right hand side of the illustration. The black button is depressed only when the door is shut tight, thereby closing a contact which then enables the machine to be started.

Simplifying Control Elements by the Use of Bimetal

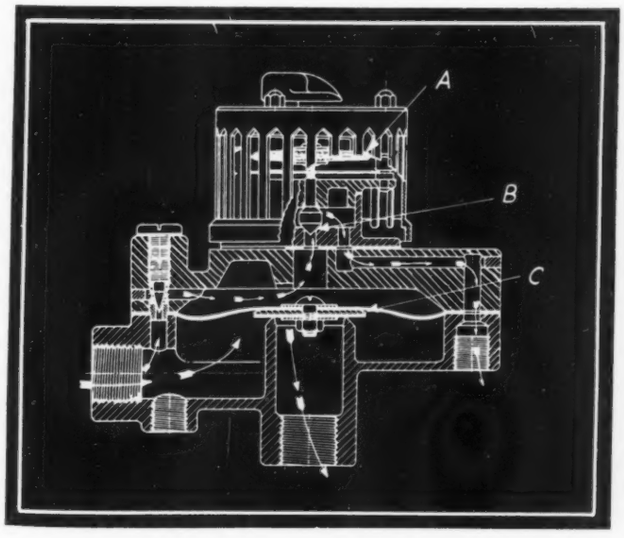
By Guy Hubbard

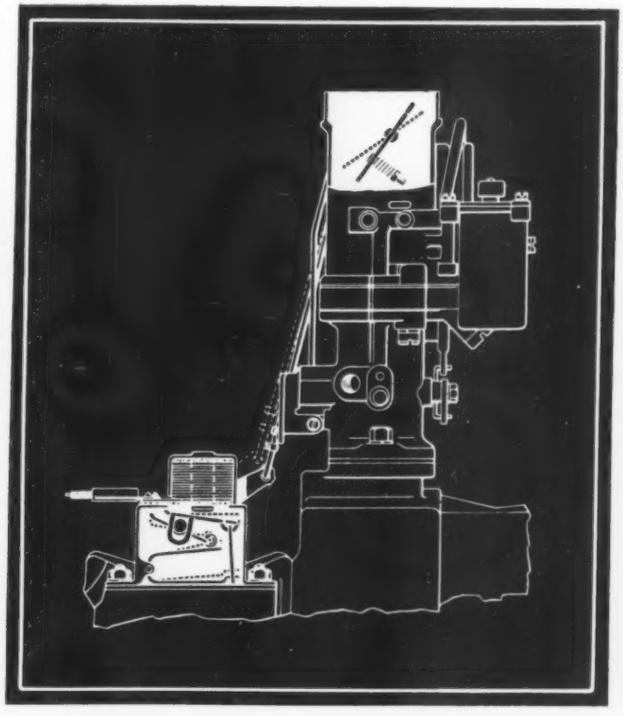
THERMOSTATIC control of the degree of heat, and similar control of mechanisms to suit changes of temperature, has become so dependable that it is more or less taken for granted. Such controls are used in devices ranging all the way from electric irons to motor cars, yet they ordinarily are recognized only in the rare event of their needing adjustment or repair, which is more apt to be on account of abuse or neglect rather than because of normal use. It is indeed a far cry from the crude stove damper controls of a century ago, which multiplied the expansion and contraction of a metal rod through a linkage system, to the compact, dependable and accurate devices which regulate automobile throttles to suit the temperature of the manifold. The development of thermostatic bimetal has played an active part in this development.

The nature of bimetal itself was covered in MACHINE DESIGN of August, 1932. Suffice it to say here that the material consists of two thin sheets of dissimilar metals which are welded together so that they become one piece. For temperatures below 300 degrees Fahr. the

Fig. 1—Below—Snap-acting bimetal element controls flow of gas to space heater

Fig. 2—Right—Bimetal sets carburetor choke according to temperature of the manifold





low expansive side ordinarily is Invar, an alloy of 36 per cent nickel and 64 per cent iron, while the high expansive side is brass, which has approximately 15 times the expansivity of Invar. By using various alloys containing iron, copper, zinc, chromium and nickel, in place of brass, bimetal can be made to function satisfactorily up to red heat—that is, 1000 to 1200 degrees Fahr.

As a few of the many applications of bimetal thermostatic controls, the following are common examples: Electric irons and ironing machines; electric toasters and grills; electric ranges and roasters; percolators; gas and electric water heaters; furnace regulators; heating pads; electric refrigerators and water coolers; automobile mixture regulators; automobile radiator regulators; hot water tank relief valves; and space heating and cooling devices. Applications to industrial machinery also are numerous.

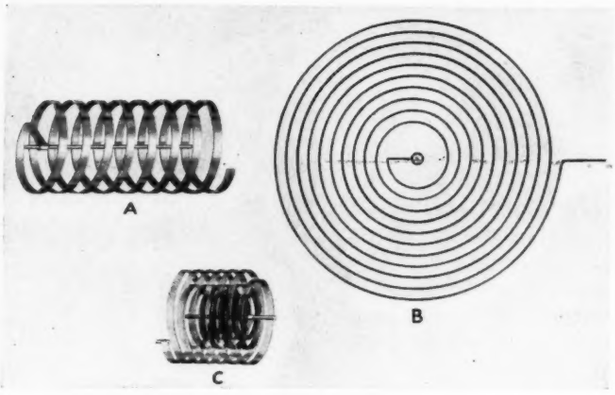


Fig. 3—These various shapes of bimetal elements give turning action when temperature changes

Space and Use Determine Shape

The basic idea of a bimetal element is that, when heated, one side of the strip expands faster than the other side, thereby warping the strip toward the low expansive side. When cooled, the reverse action takes place. In practice, the shape of the element depends upon what it is called upon to do and into what sort of space it must fit. The simplest element is the strip or reed type with one end fixed and the other free to make contacts or actuate levers. Next in order is the U-type, which may be modified into a split ring. This in turn may develop into a spiral. Again, the coil or helix type may be used. In cases where long throws are necessary, multiple helixes are employed. Other types are corrugated tube or bellows, and the reversing disc which gives snap action.

Fig. 3 shows three methods of employing bimetal strips to produce a turning movement such as is required to operate indicator hands. Helix A and spiral B are the most familiar shapes, while C represents a compound helix developed by Franz G. Bloch in Prague which now is being applied in the design of all-metal thermometers by the Weston Electrical Instrument Corp. In this "coil within coil" type, forces other than that giving angular deflection are mutually counterbalanced.

Heat of Manifold Regulates Choke

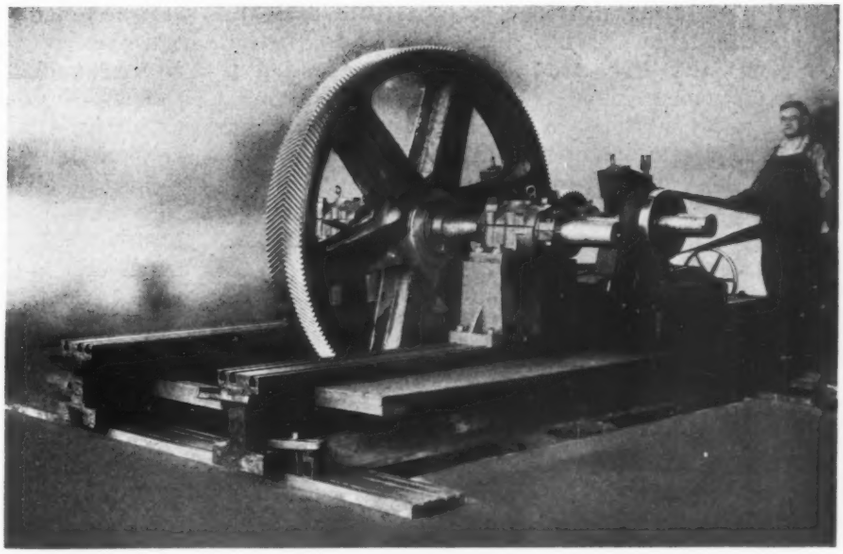
In the carburetor choke control of Dodge automobiles, ingenious use is made of a U-shaped bimetal element the function of which is to keep the choke valve adjusted according to the exhaust manifold temperature. This device, which is shown in *Fig.* 2, also makes use of an electric solenoid which comes into action when the starter pedal is depressed, temporarily holding the valve in "choke" position. *Fig.* 2 shows the position of solenoid, linkage and valve when the temperature of the manifold is 90 degrees Fahr., the dotted lines indicating what happens when the starter is in action. Instead of being fixed, the bimetal element is pivoted at the turn of the "U". In this case the bimetal is bent with the high expansive material on the outside, so that the "U" opens up when cooling and closes together when heated. The effect as the exhaust manifold cools is that the end of the upper leg of the "U" presses upward against the end of a short lever fastened to a shaft. Outside the casing this shaft carries a longer or multiplying lever linked to a lever on the pivot of the choke valve by a rod. Thus the valve is closed when the manifold is cold and opened as it grows hot.

Current flows through the solenoid coil only when the starter is working, at which time an auxiliary lever is drawn upward against the solenoid core. This lever is linked to the lower leg of the bimetal element, thereby swinging the entire element upward around its pivot and working the regular linkage to hold the choke valve closed while the solenoid is energized.

Snap-acting bimetal elements usually are made in the form of disks and are cupped slightly so that under the influence of temperature changes they suddenly reverse their shape—that is, change from concave to convex or vice versa. When these elements reverse themselves they exert considerable power momentarily. This action is especially advantageous in electrical appliances such as irons and toasters where slow acting elements would result in radio interference. They also are useful where direct power is required to operate mechanical controls at a predetermined temperature.

Fig. 1 shows a mechanical application of a snap bimetal element, this being a gas control

(*Concluded on Page* 60)



Power tests on a large diameter precision gear. By this method roundness, parallelism, diameter, center distance and tooth contacts are accurately checked and minor causes of noises are located and corrected

Gear Noise Elimination

WHILE close attention must be paid to theoretical considerations when designing gears for quietness, common sense also plays an important part. This is made clear by W. E. Sykes in the accompanying article, an abstract of a paper presented at the recent convention of the American Gear Manufacturers association in Philadelphia

ALMOST everybody responsible for the manufacture and performance of gears is troubled with gear noise. Occasionally gear noise becomes such a difficulty that the search for means to overcome it almost distracts the gear manufacturer. However, manufacturers of other products also have the noise problem to cope with.

The best definition of the word "noise" is the legal one which states that noise is a sound which creates a nuisance. From this it can be inferred that a sound is not necessarily a noise; on the other hand we cannot have a noise without a sound.

The causes of gear noise are: Faulty design; faulty workmanship; faulty lubrication; overloads.

The expression "faulty design" as here used applies not only to the gears themselves but also to the design of the shafts, the bearings, and the housing. The design of the gear teeth should be in accordance with correct geometrical principles. It should be such that the gear teeth will have correct action.

Occasionally, due to ignorance on the part of the designer, straight tooth gears are made having such a small number of teeth that the base circle pitch is larger than the length of the line of action, which makes silent operation impossible.

For quiet operation it is preferable to arrange for at least two base circle pitches along the line of contact. This necessitates a somewhat large number of teeth in the gear pair; but when there is a practical limitation of the number of teeth, then modified addenda and dedenda have to be resorted to. In general, the sum of the number of teeth in any gear pair, that is to say, the number of teeth in the pinion plus the number of the teeth in the

wheel, should not be less than sixty.

A reasonably rigid gear and pinion structure should be provided and in this dissertation the term "pinion" is intended to include worms, and the term "wheel" is intended to include worm wheels. Pinions should be large enough in diameter in proportion to their length to avoid excessive deflection, and the wheels should be so designed that they will not unduly deflect under full load and will not warp too far out of shape after being cut and heat treated.

Shafts and bearings should be sufficiently rigid; for example, the bearings should be close enough together to prevent excessive deflection of the shaft, and the bearings themselves should be sufficiently well supported to prevent excessive deflection under full load.

The design of the gear housing requires careful attention. It should be oiltight and dustproof. It should have sufficient oil capacity and ample heat radiating surface should be provided; if necessary, an oil cooler of correct capacity and of perfect reliability must be included in the design.

Great care must be exercised to select the most suitable type and size of bearings. In some cases antifriction bearings can be most advantageously used. In other cases the velocities are too high for such bearings and sleeve bearings must be resorted to. Correct lubrication for the bearings must also be provided for.

The selection of materials requires careful consideration. It is not sufficient merely to select materials which have the proper physical characteristics for the service required. It is advisable—even necessary—to consider whether such materials can be satisfactorily dealt with during the manufacturing process. For example, it would be a mistake to select a forged steel heat treated to such a degree before the gear cutting operation that it would be so hard as to damage the tools and thereby cause gear cutting inaccuracies; it would also be wrong to choose a material to be heat treated after the cutting operation which would be likely to warp unduly. When cast materials are used it is advisable to select one which will be reasonably uniform in its hardness and in its cutting characteristics.

Consider Extraneous Influences

The designer's work is not properly done unless he considers and takes care of the possible extraneous influences on the gear drive. He must take steps to prevent extraneous forces pushing the gears out of position. This generally involves the consideration of the type of couplings used. He also has to take into consideration the possibility of side thrusts due to overhanging loads being imposed on the shaft projections of the gear unit. To guard against such conditions antifriction bearings are often useful, and in many cases the tapered type of roller bearing is especially valuable. In other cases deep groove ball bearings can be used advantageously. Such bearings need very little running clearance so that any force imposed on the shafts is likely to displace them very little.

Where sleeve bearings with forced lubrication have necessarily to be employed, due to high velocity, the use of suitable flexible couplings becomes imperative, and sometimes it is also advisable to provide a thrust bearing.

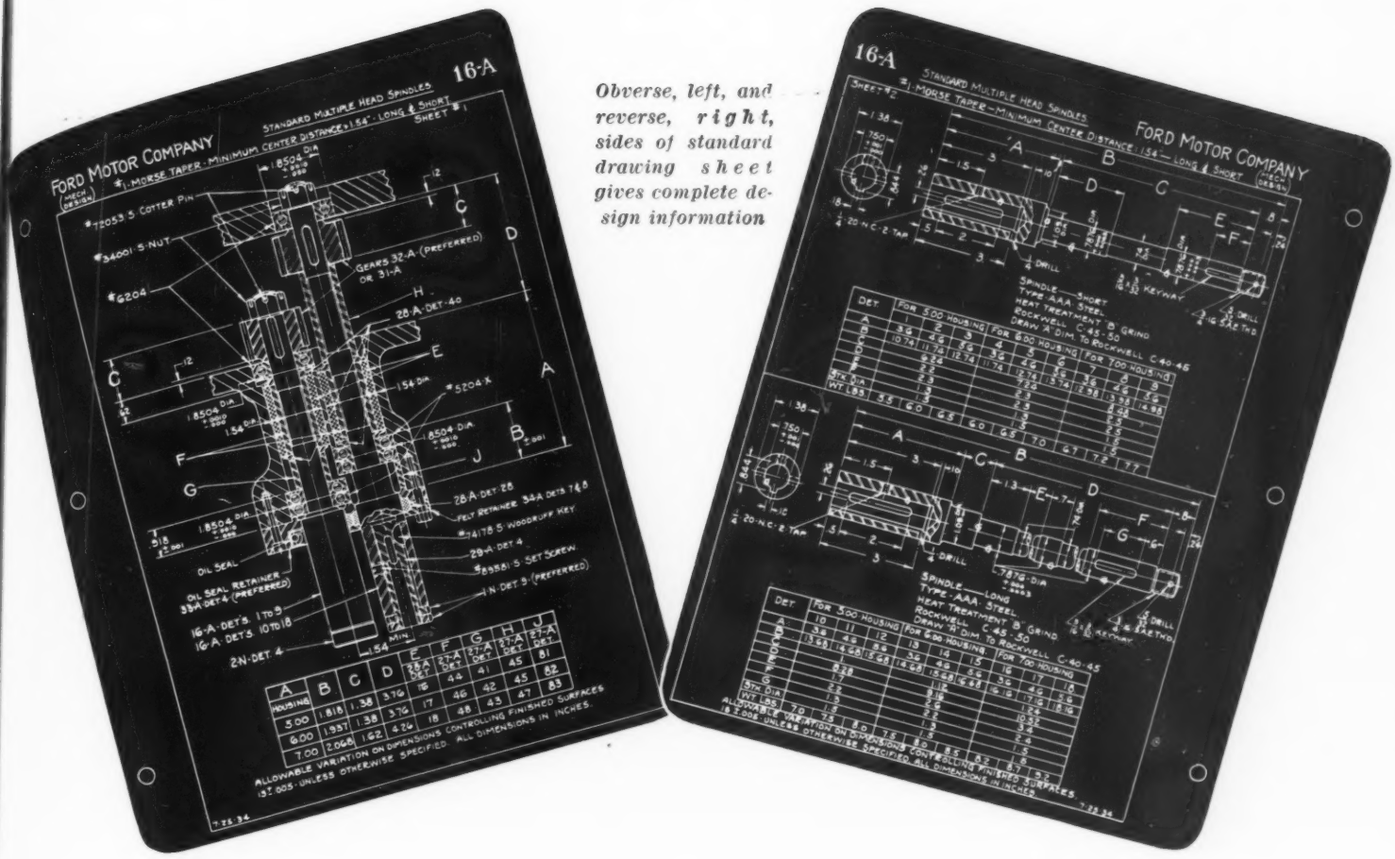
Not All Noise Due To Gears

The designer should bear in mind that occasionally gears are blamed for noises which they do not create. On many occasions the author has discovered that the noise which was attributed to gears came from bearings. Therefore the designer should make sure that the bearings themselves are not noisy.

In some cases oil noises result because the gears are immersed in too heavy a lubricant. It is the designer's duty to take care that the oil level and the nature of the lubricant is specified. In cases where the velocity of the gears exceeds a certain amount spray lubrication should be provided and it is the designer's duty to ascertain whether or not spray lubrication is required.

Although it is impossible to get satisfactory gear performance without correct design, it is equally impossible to obtain silent gears without the highest grade of workmanship. Most gear noises are caused by faulty workmanship. There are frequently many excuses for poor workmanship. Such words as "harmonics", "resonance", and "sound amplification" are often used in connection with gear noises, but in the author's experience more than ninety per cent of the trouble has been due to inferior workmanship. The word "workmanship" here applies not only to the gears themselves but also to the housing, the bearings, the shafts, the alignments and the installation.

Those who have had experience in testing gears for silence are well aware that any particular pair of gears may run silent at certain loads and become noisy at other loads. Some gears will run perfectly silent at no load but will make a noise when carrying only ten per cent of the designed load. Others will, for example, run silent at fifty per cent of the load and noisy at one hundred per cent of the load. Again others will run silent at full load and may be noisy at fifty per cent overload. Others again will run silent at any load which does not result in damage to the tooth surface or to the shafts and bearings. It is therefore desirable when investigating a noise complaint to make sure that the gear is not overloaded.



Obverse, left, and reverse, right, sides of standard drawing sheet gives complete design information

Save Time with Standards!

STANDARD parts drawings can be employed to form the basis for the simplest and most successful method of reducing the number of tracings in the file. Such standard drawings can include all parts used frequently in a line of machines, or in different models of the same machine. With their use it becomes unnecessary for the designer to draw up the same part repeatedly, and this is intended to include parts with only minor changes from the standard.

Minor, relatively unnecessary changes should be discouraged when a standard has been set up. However, the standard drawings should not be allowed to hold back beneficial changes of a more important nature.

Quite frequently a drawing such as the one shown in the accompanying illustration can be made to cover various sizes of the same part. This drawing, one of a series prepared for designers of Ford Motor Co., covers standard multiple head spindles, and, as can be seen, varying sizes of the spindles are accommodated on the same sheet.

Compiled in Standards Book

In the Ford company these drawings are made up into a standards book which each designer keeps for ready reference. Deviations from this book are infrequent, and considerable design time is saved for creative effort. Also kept in the standards book is an alphabetical and numerical index of all drawing number divisions maintained by the company, thus furnishing the designer a great deal of information that considerably simplifies the routine portion of his job.

Disk Springs Facilitate Compactness

By J. O. Almen and A. Laszlo

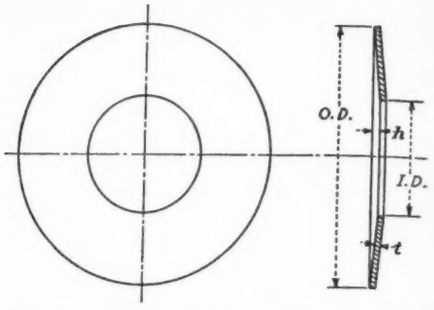


Fig. 2—Annular disk springs, as shown have a wide range of application

A WIDE variety of load-deflection curves not usually obtainable may be secured with initially coned annular-disk springs designed by the formulas given by the authors, research laboratories, General Motors Corp. Abstracted from a paper presented at a recent Mechanical Engineers' meeting.

IN ADDITION to compactness along the axis of loading, the initially coned, annular-disk spring of uniform cross section may be proportioned to give a wide variety of load-deflection characteristics not readily obtainable with the more conventional forms of springs. By the simple expedient of varying the free cone height and the working range of deflections, spring rates may be varied from positive to zero to negative. The load-capacity and deflection range may be varied by the use of multiple springs arranged in series or parallel.

The versatility of the annular-disk spring has long been indicated. However, formulas heretofore available have not been presented in a manner to disclose readily the effect of spring proportions on characteristics.

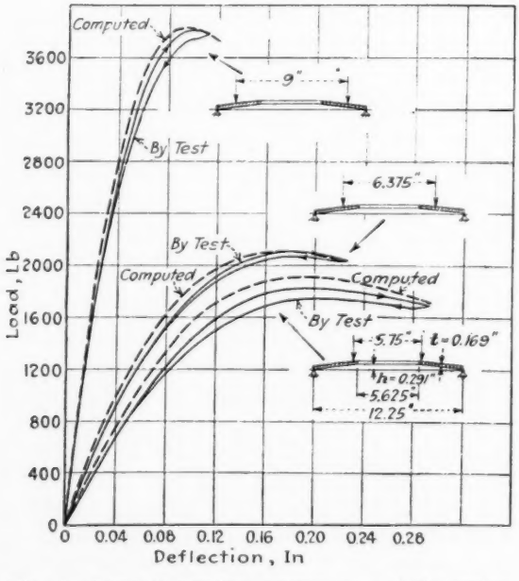


Fig. 1—Load deflection curves of a disk spring loaded at various diameters

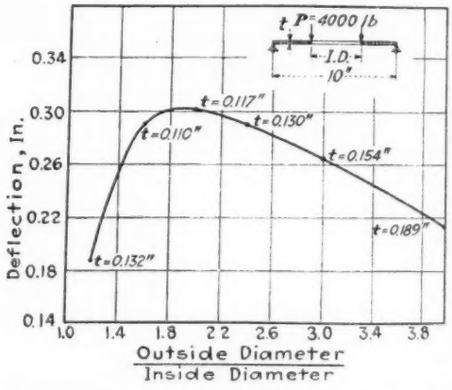


Fig. 3—Influence of outside-diameter-inside-diameter ratio on the flexibility of an initially flat disk spring

In this article, it has been attempted to present formulas in a manner to aid the designer in arriving at suitable characteristics by choice of spring geometry. These new formulas have been in use for several years at the General Motors Corp. research laboratories section, and their reliability has been checked by tests of springs used in a variety of special test equipment. Experience has covered springs varying in outside diameter from 1 to 12 inches, springs with ratios of outside to inside diameter from 1.4 to 5.5, and springs with ratios of free cone height to thickness giving practically the full range of charac-

teristics plotted in *Fig.* 5. The present formulas are shown to be reliable for prediction of load-deflection curves. Lack of information on true stresses does not detract from their utility. Computed permissible maximum stresses for static loading are quite high, in the neighborhood of 220,000 pounds per square inch, but experience indicates that these values may be used for design purposes when using plain carbon steel.

Our present interest is in the annular-disk spring of the type shown in *Fig.* 2. Asuming first that angular deflection of the cross section is relatively small, second that the cross section remains undistorted in the deflected position,

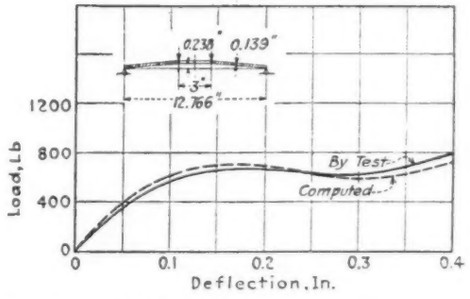


Fig. 4—*Load-deflection curves of a spring with large outside-diameter-inside-diameter ratio*

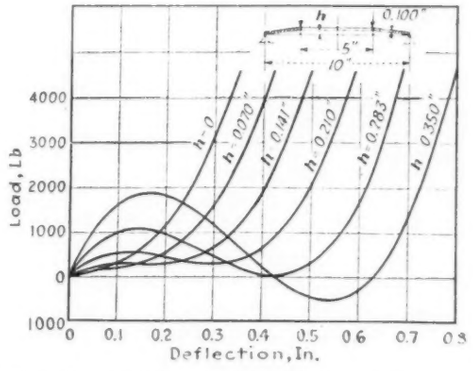


Fig. 5—*Computed load-deflection curves of six disk springs identical except for height*

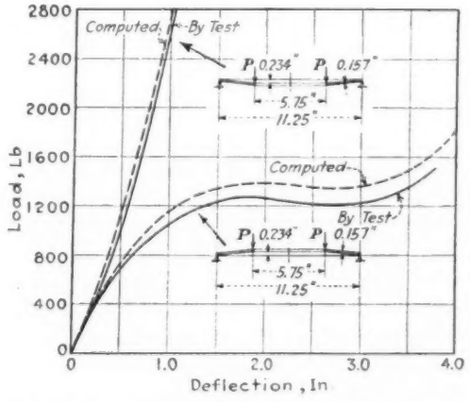


Fig. 6—*Load-deflection curves of a disk spring loaded in two directions*

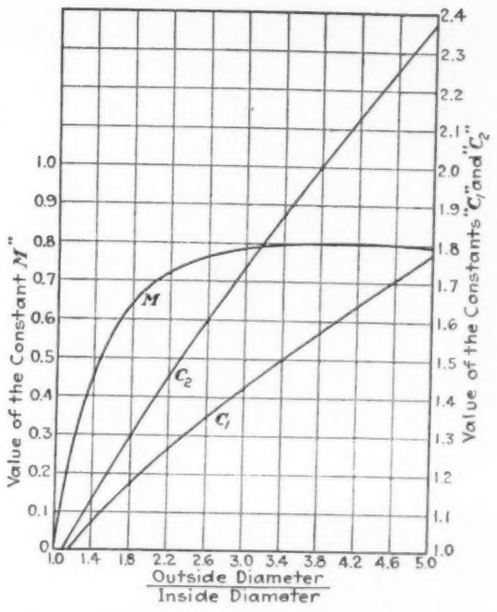


Fig. 7—*Load and stress constants for calculating disk springs of all types*

and third that loading and support are uniformly distributed around the circumferences, we obtain the following formulas for dished springs.

The formula for the load is

$$P = \frac{E\,\delta}{(1-\sigma^2)\,M\,a^2}\left[(h-\delta)(h-\delta/2)\,t + t^3\right]$$

The maximum stress in the upper edge is

$$S = \frac{E\,\delta}{(1-\sigma^2)\,M\,a^2}\left[C_1(h-\delta/2) + C_2 t\right]$$

The maximum stress in the lower edge is

$$S = \frac{E\,\delta}{(1-\sigma^2)\,M\,a^2}\left[C_1(h-\delta/2) - C_2 t\right]$$

where a = outside radius = half outside diameter, t = thickness, h = free height = height of truncated cone formed by the upper or lower surface, δ = axial deflection, E = modulus of elasticity, σ = Poisson's ratio, M, C_1, C_2 = constants given in a function of outside-diameter-inside-diameter ratios. The values of these constants are given in *Fig.* 7.

Fig. 5 shows load-deflection curves calculated for a series of springs having the same diameter and thickness but varying in initial cone height h. That these theoretical characteristics are obtainable in practice is shown by *Fig.* 4.

In calculating the curves shown in *Fig.* 5, the load was assumed applied in the direction indicated. Another group of curves can be obtained from the same springs by applying the load in the opposite direction, as shown, for example, in *Fig.* 6.

Springs having load-deflection curves of the type h = 0.141 inch shown in *Fig.* 5 and the lower curve in *Fig.* 6 are often very useful inasmuch as they have a deflection range in which the load changes only very

slightly, that is, a deflection range of low spring rate. This type curve is obtained when h is of the order of $t\sqrt{2}$. By making h somewhat greater than $t\sqrt{2}$, a region of slight negative rate is obtained, which increases the total deflection range of low spring rate. Where permissible, this is a useful expedient. When such low-rate springs are used, they permit fairly wide tolerances in the preload deflection without alteration of load. As discussed later in this paper, the actual load given by the spring may, if necessary, be readily adjusted by alteration in the radial location of support or point of loading.

An example of a machine design using such low-rate disk springs is shown in *Fig.* 8, wherein a live tailstock center is shown equipped with two disk springs in parallel arranged to take

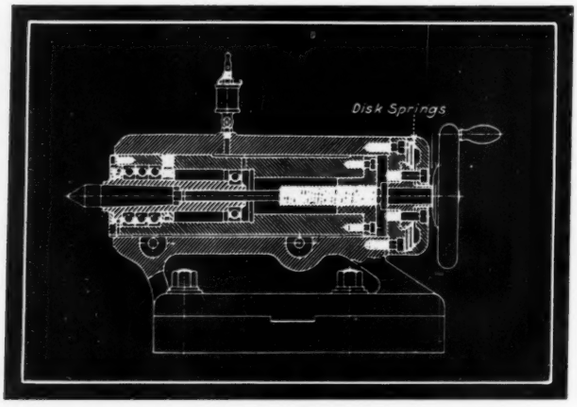


Fig. 8—*Thrust load of the bearings is taken by two disk springs arranged in parallel*

the thrust load of the bearings. The springs have a deflection range of 0.1 inch in which the load is practically constant, thus allowing for work expansion when long pieces are being machined without overloading the bearing.

Fig. 1 shows how the load capacity may be varied without alterations of any kind to the spring but by variation in the point of load application. As a first approximation, the load varies inversely as the length of the arm of the couple tending to rotate the cross section, and the deflection at the load varies directly as the length of the arm of the couple tending to rotate the cross section. The test curves shown in *Fig.* 1 show also the friction hysteresis loop resulting from the slight slip that occurs between the loading ring and the spring, and between the spring and the supporting ring, when these members are rigid. The width of the loop appears to bear no fixed relation to the load, as found also in other tests. Disk springs loaded in parallel have interspring friction, whereas springs loaded in series have friction at the loading and support points only. Hence, the amount of friction damping may be varied.

The effect of the outside-diameter-inside-diameter ratios on the flexibility of disk springs is shown in *Fig.* 3. The curve in this figure considers an initially flat spring of given diameter stressed to 200,000 pounds per square inch maximum under a 4000 pound load, the spring thickness being varied as shown to maintain these conditions. It will be seen that the maximum flexibility is obtained when the outside diameter is approximately twice the inside diameter. These are also approximately the proportions for best resiliency or the maximum ratio of energy storage to spring weight. The resiliency of uniform-section disk springs is somewhat lower than for most other forms of springs due to the nonuniform stress distribution. Somewhat better resiliency can be obtained from disk springs with radially tapered sections as shown by Brecht and Wahl[1] but the added resiliency of such springs is obtained at the expense of increased cost. As a rough approximation, it may be said that the uniform-section disk spring has a resiliency one-half that of a coil spring.

Tangential Stresses in Annular-Disk Springs

True stresses in the annular-disk spring are unknown. However, a background of experience is available which has established theoretical values which may be used for static loading.

In the practical design of these springs, it is found that they will function satisfactorily under static loading when operating under computed stress as high as 220,000 pounds per square inch even though made from steel having a yield point of 120,000 pounds per square inch. The apparent high stress capacity of disk springs may, in part, be due to shortcomings of the stress formula, due in turn to simplifying assumptions. These high values for computed stress are at the inner circumference. If it is assumed that the stress exceeds the yield point, there must be a redistribution of stress due to localized yielding. If, when loaded, the stress in the more highly stressed regions of the disk spring were redistributed as a result of yield, it follows that the unloaded spring will have residual stresses. This is substantiated by the fact that tests show a small initial loss in free cone height. The stress distribution suggests that important increase in fatigue life should result from careful rounding of the corners of disk springs. Test data support this view.

The safe stress of disk springs will, of course, vary with the type of service. There are not sufficient data now available to fix stress limits for dynamic applications. The fatigue tests which have been run indicate that, for a moderate stress range, a computed maximum stress of 180,000 pounds per square inch may be used. Only fatigue tests on actual springs can finally determine the true working limits.

[1] "The Radially Tapered Disk Spring," by W. A. Brecht and A. M. Wahl, Trans., A. S. M. E., vol. 52, part 1, 1930, paper APM-57-4, pp. 44-45.

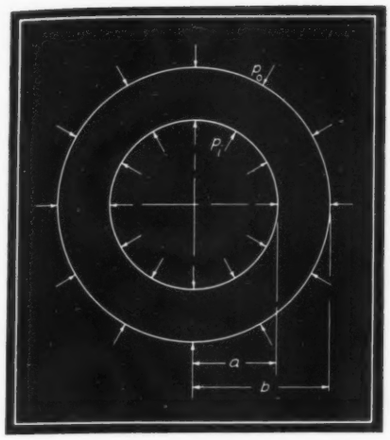


Fig. 1—Left—Shrink fit calculations are based on radial deformation of a cylinder acted upon by uniformly distributed internal and external pressures. Fig. 2—Right —All problems can be represented by two cylinders

How Shrink Fits Affect Bearing Clearance

By William O. Clinedinst
Timken Roller Bearing Co.

PRESSING or shrinking a bushing, or bearing race, in place always affects the inside and outside diameters of the bushing to a greater or lesser degree. These changes in dimensions may have an important effect upon accuracy, precision, production and cost. Data on this subject may be secured by actual test, but such procedure may be expensive, or require too much time. However, such information will permit economy of materials, improve precision and facilitate assembly.

For example, bushings may be finish-machined to provide proper running clearance when installed if it is known in advance how much they will contract when pressed or shrunk in a sleeve or housing. In the case of non-adjustable antifriction bearings, the expansion and contraction of the races is particularly important, as it will materially affect the running clearance and the consequent performance of the bearings.

Deformations resulting from press or shrink fits can be calculated readily, eliminating the necessity and expense of a series of physical tests. However, it is not reliable to make an arbitrary assumption that a certain percentage of the fit will be transmitted through the bushing or bearing race. The following procedure has been found satisfactory for solving problems of this nature.

Expression for Radial Deformation

When the material is not stressed beyond the proportional limit, the following expression for radial deformation of a cylinder acted upon by uniformly distributed internal and external pressures, *Fig.* 1, found in Timoshenko's "Strength of Materials", Part II, Page 533, applies:

$$U_r = \frac{1-\mu}{E} \times \frac{a^2 p_i - b^2 p_o}{b^2 - a^2} \times r + \frac{1+\mu}{E} \times \frac{a^2 b^2 (p_i - p_o)}{(b^2 - a^2) r} \quad \ldots\ldots (1)$$

where

a = inner radius
b = outer radius
p_i = inner pressure
p_o = outer pressure
E = modulus of elasticity
μ = Poisson's ratio
U_r = radial deformation at radius r
r = radius

All problems in press or shrink fits can be represented by two cylinders, the smaller cylinder having its outer radius larger by δ than the inner radius of the larger cylinder. If the larger is pressed or shrunk on to the smaller, each is deformed and a contact pressure between the two produced. This pressure can be determined and the deformation of each cylinder calculated with the following factors, based on *Fig.* 2:

E_o = modulus of elasticity of outer cylinder
E_i = modulus of elasticity of inner cylinder
μ_o = Poisson's ratio of outer cylinder
μ_i = Poisson's ratio of inner cylinder
δ = press or shrink fit on radius between inner and outer cylinder
p = contact pressure between cylinders
U_{bo} = increase of inner radius of outer cylinder
U_{bi} = decrease of outer radius of inner cylinder
U_a = decrease of inner radius of inner cylinder
U_c = increase of outer radius of outer cylinder

Determines Contact Pressures

The magnitude of p can be determined from the condition that the sum of the magnitudes of the deformations of both cylinders at the radius b caused by p must be equal to δ.

This condition can be expressed as the following equation:

$$U_{bo} - U_{bi} = \delta \quad \text{.....(2)}$$

The expressions for U_{bo} and U_{bi} are obtained from equation (1), as

$$U_{bo} = \frac{b\,p}{E_o}\left[\frac{b^2+c^2}{c^2-b^2} + \mu_o\right] \quad \text{.....(3)}$$

$$U_{bi} = \frac{-b\,p}{E_i}\left[\frac{a^2+b^2}{b^2-a^2} - \mu_i\right] \quad \text{.....(4)}$$

Substituting equations (3) and (4) into equation (2),

$$\frac{b\,p}{E_o}\left[\frac{b^2+c^2}{c^2-b^2} + \mu_o\right] + \frac{b\,p}{E_i}\left[\frac{a^2+b^2}{b^2-a^2} - \mu_i\right] = \delta$$

Solving for p

$$p = \frac{\delta}{\frac{b}{E_o}\left[\frac{1+(b/c)^2}{1-(b/c)^2} + \mu_o\right] + \frac{b}{E_i}\left[\frac{1+(a/b)^2}{1-(a/b)^2} - \mu_i\right]} \quad \text{.....(5)}$$

using this value for p, the following expressions for U_a and U_c are obtained from equation (1), on page 43:

$$U_a = \frac{-2a}{E_i[1-(a/b)^2]} \times p \quad \text{.....(6)}$$

$$U_c = \frac{2b(b/c)}{E_o[1-(b/c)^2]} \times p \quad \text{.....(7)}$$

When the inner and outer cylinders are of the same material, equations (5), (6) and (7) can be simplified and combined and are found to be independent of elastic constants.

Equations Are Combined

Combining equations (5) and (6) and taking into consideration that $E_o = E_i$ and $\mu_o = \mu_i$,

$$U_a = \frac{-(a/b)[1-(b/c)^2]}{[1-(a/c)^2]} \times \delta \quad \text{.....(8)}$$

Combining equations (5) and (7) and taking into consideration that $E_o = E_i$ and $\mu_o = \mu_i$,

$$U_c = \frac{(b/c)[1-(a/b)^2]}{[1-(a/c)^2]} \times \delta \quad \text{.....(9)}$$

For the case of a bushing shrunk or pressed on a solid shaft of the same material as the bushing, equation (9) becomes:

$$U_c = (b/c) \times \delta \quad \text{.....(10)}$$

With equations (5), (6), (7), (8), (9) and (10) all problems involving the deformations of cylindrical bushings can be solved. Strictly speaking, these equations apply only to cylindrical bushings but can be used in approximating the deformations of bushings not having constant diameters by using mean diameters.

Gives Typical Examples

Some examples of the application of these equations to the solution of typical problems are as follows:

PROBLEM No. 1: Find the decrease in the inside diameter of 2.002-inch O.D. by 1.5-inch I.D. bronze bushing by pressing it into a 2.5-inch O.D. by 2-inch I.D. cylindrical cast iron housing.

$E_o = 12 \times 10^6$	$\delta = 0.001''$	$a/b = 0.75$	$(a/b)^2 = 0.562$
$E_i = 10 \times 10^6$	$a = 0.75''$	$b/c = 0.80$	$(b/c)^2 = 0.64$
$\mu_o = 0.270$	$b = 1.00''$		
$\mu_i = 0.333$	$c = 1.25''$		

From equation (5)

$$p = 0.001 \div \left\{\frac{0.75}{12\times10^6} \times \left[\frac{1+0.64}{1-0.64} + 0.270\right] + \frac{0.75}{10\times10^6} \times \left[\frac{1+0.562}{1-0.562} - 0.333\right]\right\} = 1840 \text{ pounds per square inch}$$

From equation (6)

$$U_a = \frac{-2(0.75)}{10\times10^6(1-0.562)} \times 1840 = -0.000632 \text{ inch}$$

The decrease in inside diameter $= 2 \times 0.000632 = 0.00126$ inch.

PROBLEM No. 2: Find the increase of the outside diameter of a 2-inch O.D. by 1.5-inch I.D.

bronze bushing when pressed on a 1.502-inch solid steel shaft.

$E_o = 10 \times 10^6$	$\delta = 0.001''$	$a/b = 0$	$(a/b)^2 = 0$
$E_i = 30 \times 10^6$	$a = 0$	$b/c = 0.75$	$(b/c)^2 = 0.562$
$\mu_o = 0.333$	$b = 0.75''$		
$\mu_i = 0.303$	$c = 1.00''$		

From equation (5)

$$p = 0.001 \div \left\{ \frac{0.75}{10 \times 10^6} \times \left[\frac{1+0.562}{1-0.562} + 0.333 \right] + \frac{0.75}{30 \times 10^6} \times \left[\frac{1+0}{1-0} - 0.303 \right] \right\} = 3240 \text{ pounds per square inch}$$

From equation (7)

$$U_c = \frac{2(0.75)(0.75)}{10 \times 10^6 (1-0.562)} \times 3240 = 0.00083 \text{ inch}$$

The increase in outside diameter $= 2 \times 0.00083 = 0.00166$ inch.

Finds Diameter Decrease

PROBLEM No. 3: Find the decrease in the inside diameter of a 2.002-inch O.D. by 1.5-inch I.D. bushing by pressing it into a 2.5-inch O.D. by 2-inch I.D. cylindrical housing of the same material:

$\delta = 0.001''$	$a/b = 0.75$	
$a = 0.75''$	$b/c = 0.8$	$(b/c)^2 = 0.640$
$b = 1.00''$	$a/c = 0.6$	$(a/c)^2 = 0.360$
$c = 1.25''$		

From equation (8)

$$U_a = \frac{-0.75(1-0.64)}{(1-0.36)} \times 0.001 = -0.000422 \text{ inch}$$

The decrease in outside diameter $= 2 \times 0.000422 = 0.00084$ inch.

PROBLEM No. 4: Find the increase of the outside diameter of a 2-inch O.D. by 1.5-inch I.D. bushing when pressed on a 1.502-inch O.D. by 1-inch I.D. hollow shaft of the same material.

$\delta = 0.001''$	$a/b = 0.667$	$(a/b)^2 = 0.445$
$a = 0.5''$	$b/c = 0.75$	
$b = 0.75''$	$a/c = 0.5$	$(a/c)^2 = 0.25$
$c = 1.00''$		

From equation (9)

$$U_c = \frac{0.75(1-0.445)}{(1-0.25)} \times 0.001 = 0.000555 \text{ inch}$$

The increase in outside diameter $= 2 \times 0.000555 = 0.00111$ inch.

PROBLEM No. 5: Find the increase in the outside diameter of a 2-inch O.D. by 1.5-inch I.D. bushing by pressing on a 1.502-inch solid shaft of the same material.

$\delta = 0.001''$
$b = 0.75''$
$c = 1.00''$

From equation (10)

$$U_c = \left(\frac{0.75}{1.00} \right) \times 0.001 = 0.00075 \text{ inch}$$

The increase in outside diameter $= 2 \times 0.00075 = 0.0015$ inch.

Edison Still Holds Record for Number of Patents

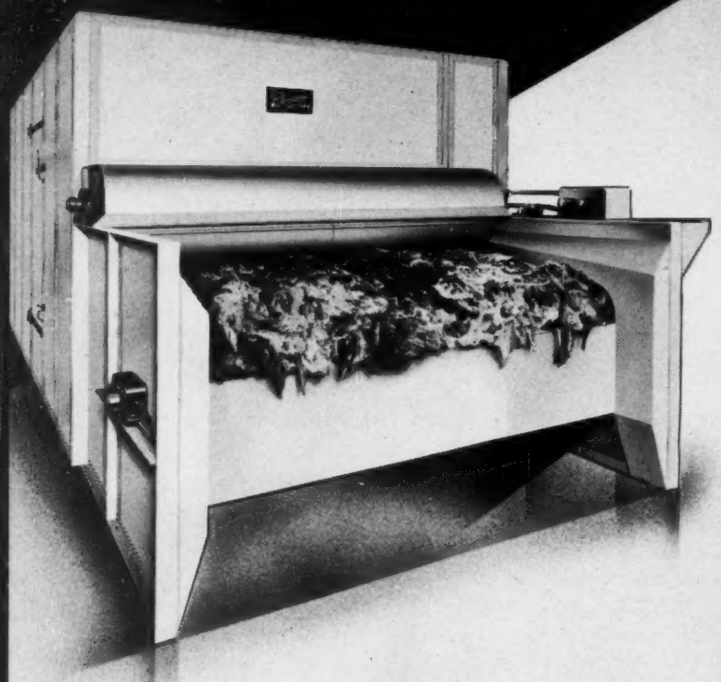
IN A LETTER to the magazine *News-Week*, Raymond J. Brown, editor, *Popular Science Monthly*, sets forth the results of his investigation as to who—after Edison with his 1099 United States patents—are America's most prolific inventors. A corps of professional researchers combed the records of the United States Patent office, in some cases 45 years being covered by the career of a single inventor. Leading American patentees and the number of patents issued to them up to November, 1935, are:

John F. O'Connor, Chicago, Ill., (railway equipment) 949; Elihu Thompson, Lynn, Mass. (electricity) 696; Carleton Ellis, Montclair, N. J. (chemistry, including synthetic resins) 648; Henry A. Wise Wood, New York (printing machinery) 434; John Hays Hammond Jr., Gloucester, Mass., (radio) 360; Clyde C. Farmer, Wilmerding, Pa., (air brakes) 344; Ethan I. Dodds, Central Valley, N. Y., (railway equipment) 321; Edward Weston, Newark, N. J. (electrical measuring instruments) 309.

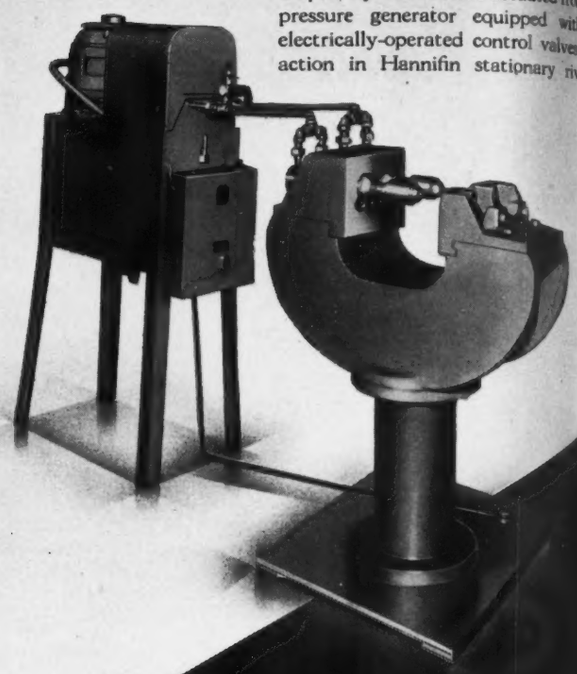
Mr. Brown comments as follows: "The average man undoubtedly would be unable to identify more than one or two from this list, yet they are 'the new Edisons'." He adds, however, that ". . . . . prolixity in invention is only part of the story. Alexander Graham Bell, for example, obtained exactly twenty-four patents, the Wright brothers only five."

Mechanism Signals Theft

Today's thief is encountering opposition not only from the police, but also from ingenious engineers who are making the get-a-way extremely hazardous. A recently devised bag for carrying valuables has a unique mechanism inside it which marks anyone carrying the bag beside the rightful owner as a thief. Taking the bag from the messenger releases a mechanism which locks the bag inside; ten seconds later this mechanism discharges (through the bottom of the bag) four .45 calibre blank noise loads and two charges of dense tracer smoke that issue without interruption for three or more minutes.



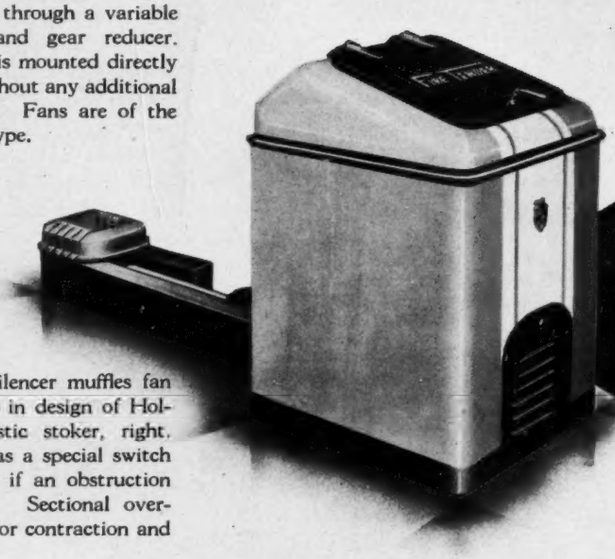
rive for conveyor in Proctor dryer, ove, is by a motor through a variable eed transmission and gear reducer. ach fan in the unit is mounted directly the motor shaft without any additional earings or couplings. Fans are of the overload turbine type.



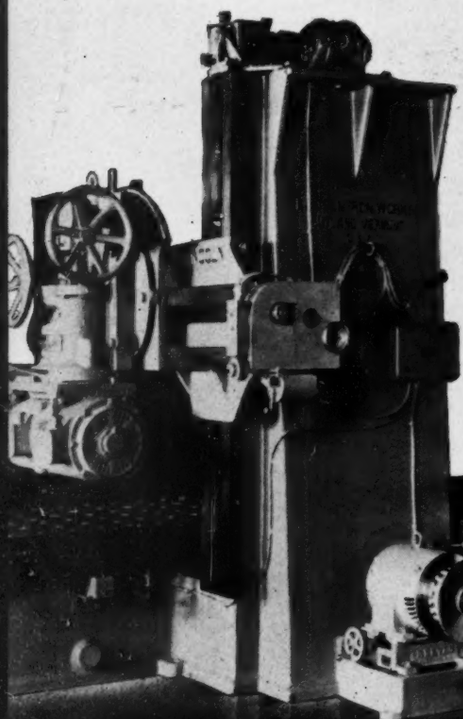
Duplex hydraulic rams actuated from a new typ pressure generator equipped with automati electrically-operated control valves provide th action in Hannifin stationary riveter, below

Design Fe in New Ma

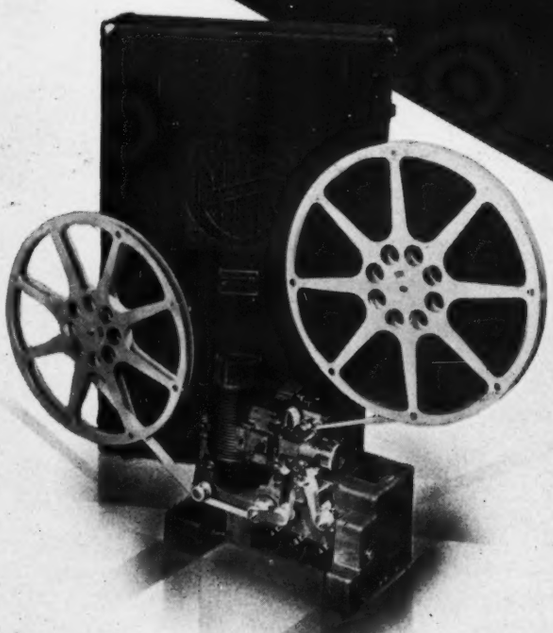
A Pictorial Presentation of Re from the Standpoint o



und insulated fan silencer muffles fan ise to the minimum in design of Hol-mb & Hoke domestic stoker, right. shear pin is used as a special switch connects the motor if an obstruction ps the screw feed. Sectional over-ping tuyeres allow for contraction and pansion.



Universal head on Lincoln stone grinding machine, left, may be tilted and locked in any intermediate position. Variable speed is obtained through a special pulley mounted on the shaft of the driving motor. Table reversal is automatic. Operation is by push-buttons.



Sound head on new sound-on-film reproducer of Bell & Howell, above, embraces a rotating sound drum and a film shrinkage compensating "floating idler". A balanced flywheel, rotating as an integral part of the sound drum assembly, assures constant speed.

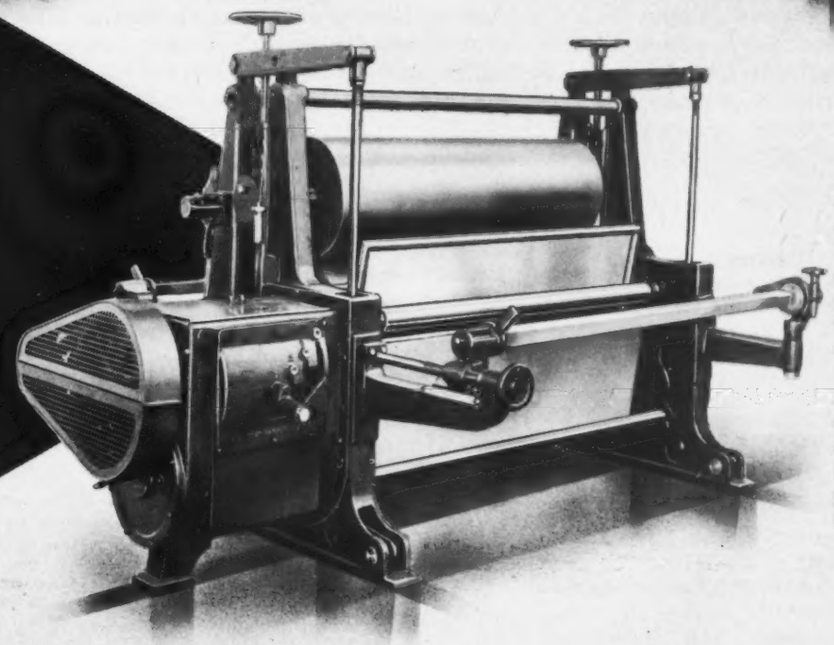
cuated from a new type
opped with automatic
rol valves provide the
onary riveter, below.

n Features
v Machines

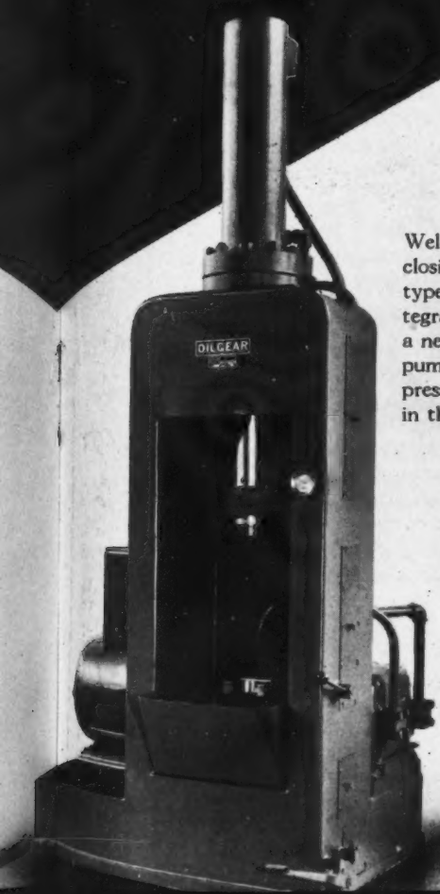
entation of Recent Machinery
Standpoint of Design.

Use of a direct-driven unit enabled modern styling for Creamery Package auto-speed Babcock tester, below. Brake handle extends through the top cover and when pressure is applied a spring is compressed, permitting pressure to be exerted against the braking surface directly mounted on the vertical shaft.

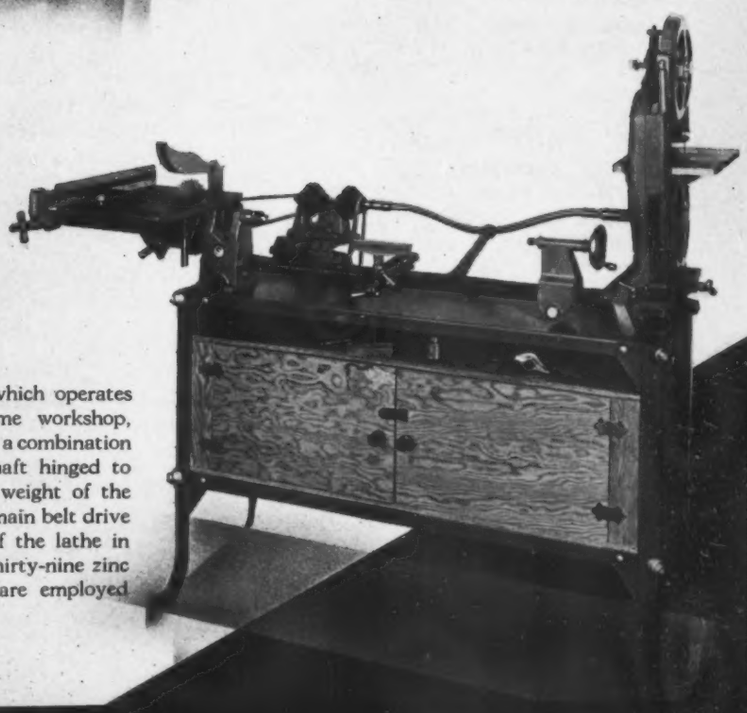
Gear speeder is designed so that pairs can be run together under loads both forward and reverse while checking, this is made possible on Michigan machine, right, by using two spindles, each having its own drive and brake, and controlled by a single handwheel.



Square bar on which of cloth is introduce Morrison pad dyeing chine, left, is swivelle one side and adjustab the other to allow operator to hold the f threads of the fabri right angles to the threads. Immersion rc stainless steel, is mou in self-aligning housin permit it to run perf free.



Welded steel construction, enclosing control mechanisms, bottle type double acting cylinder, integral pump and motor base, and a new variable delivery hydraulic pump feature Oilgear two-column press, left. A bronze bushing in the yoke guides the ram.



Reversible motor which operates Walker-Turner home workshop, right, is mounted on a combination bracket and jackshaft hinged to the table top, the weight of the motor keeping the main belt drive to the headstock of the lathe in correct tension. Thirty-nine zinc alloy die castings are employed in this machine.

New Machines Indicate Design Trends

SIMPLIFIED control, always important in design, is assuming an even greater degree of attention because of the difficulty some manufacturers are encountering in finding sufficiently skilled workmen. It is extremely important that workmen learn to operate a machine within a very short time. When the available men have not had sufficient training or experience, it is difficult for them to cope with involved controls. Therefore, the designer is bending every effort toward making his machine as easy to operate as is humanly possible. Parts makers are co-operating with the introduction of easily-mastered remote controls, electric, hydraulic and mechanical, that reduce operating jobs to a minimum.

Machines recently announced in addition to those on the preceding two pages include the following, arranged by fields of application.

Barber

Hair Clippers, Allover Mfg. Co., Kansas City, Mo.

Chemical

Centrifugal Machine, American Tool & Machine Co., Boston.

Construction

Finish Spreading Machine, Blaw-Knox Co., Pittsburgh.

Black Top Scarifyer, Austin-Western Road Machinery Co., Aurora, Ill.

Portable Crushing and Screening Plant, Diamond Iron Works, Minneapolis.

Domestic

Electricity Generating Unit, United States Motors Corp., Oshkosh, Wis.

Oil Burner, Electrol Inc., Clifton, N. J.

Vacuum Cleaners, Cleveland Suction Cleaner Co., Cleveland.

Washing Machines, Voss Bros. Mfg. Co., Davenport, Ia.

Stokers, Butler Mfg. Co., Kansas City, Mo.

Foundry

Abrasive Cut-Off Machine, Tabor Mfg. Co., Philadelphia.

Cut-Off Machine for Dry Cuts, Cyril A. Fox, Pittsburgh.

Sieve Shaking Machine, Great Western Mfg. Co., Leavenworth, Kans.

Industrial

Electric High Temperature Laboratory Furnace, Duncan Mackenzie's Sons Co., Trenton, N. J.

Materials Handling Electric Elevator, Barrett-Cravens Co., Chicago.

Small Diesel Engines, Witte Engine Works, Kansas City, Mo.

Metalworking

100-Ton Horizontal Swaging Press, Oilgear Co., Milwaukee.

Spring Grinding Machine, Baldwin-Southwark Corp., Philadelphia.

Four Column 100-Ton Hydraulic Press, Defiance Machine Works, Defiance, O.

Precision Thread Grinder, Ex-Cell-O Aircraft & Tool Corp., Detroit.

Radial Drill, Morris Machine Tool Co., Cincinnati.

Crankshaft Lathe, R. K. LeBlond Machine Tool Co., Cincinnati.

Mining

Self-Propelled Mechanical Shovel, Eimco Corp., Salt Lake City.

Office

Posting Machine, National Cash Register Co., Alliance, O.

Packaging

Can Printing Machine, J. H. Matthews & Co., Pittsburgh.

Bottle Feeding Disk, Horix Mfg. Co., Pittsburgh.

Labeling Machine, White Labeling Machine Co., Minneapolis.

Printing

Saw Trimmer, Hammond Machinery Builders Inc., Kalamazoo, Mich.

Store

Cash Register, McCaskey Register Co., Alliance, O.

Textile

Single Unit Full Fashioned Hosiery Machine, Alfred Hofmann Inc., West New York, N. J.

Automatic Transfer Machine, St. Joseph Iron Works, St. Joseph, Mich.

Dyeing Machine, Rochester Engineering & Centrifugal Corp., Rochester, N. Y.

Automatic Cleaning System, American Monorail Co., Cleveland.

Woodworking

Wood Shaping Machine, Indiana Foundry Machine & Supply Co., Brazil, Ind.

MACHINE DESIGN

Flexibility of Mind Is Essential in Designing Machines

TWO distinct schools of thought exist on many design matters. Instances which can readily be cited include such controversial points as plain versus antifriction bearings, welded or cast construction, and automatic or visual oiling.

Not the least important of these much-discussed phases of design is the question of electric versus hydraulic control. This applies particularly to the machine tool industry. For the past six or seven years there has been a distinct trend toward hydraulic feed mechanism, gaining in popularity and momentum to such an extent that the same method of actuation has become popular in numerous other types of machines.

Available evidence points to the success of hydraulic operation. That all companies are not in entire agreement, however, is evidenced by the number of machine tool builders who have not adopted this principle or shown any inclination toward doing so. In fact, certain engineering departments have taken advantage, instead, of the improved systems of electrical control that have been developed over the same period, and have more completely electrified their machines.

An instance of such design is given in this issue. Three built-in motors are utilized and the entire machine is controlled electrically. It is a contribution to design and bespeaks the advance that electrical control has made over the past few years.

Change!

WITH "Old Man Depression" headed for oblivion there could be no better time to consider transfers, promotions and other factors concerning personnel. MACHINE DESIGN already has effected certain changes of this nature. Readers unfortunately will miss the contributions of Harold B. Veith, associate editor of the journal since its inception, who has moved into the business department.

Guy Hubbard, as will be noted from the personal columns of this issue, has been appointed associate editor. He comes to the journal with a wealth of experience in design, and we are confident that members of the engineering profession in which he already is well known will welcome his articles and his influence on the journal as a member of the editorial staff.

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Why Use a Metric System?

To the Editor:

IT SEEMS peculiar that in a country which, I believe, almost universally uses the English system of measurement, practically all of the companies that make ball bearings use the metric system of measurement on both the inner and outer races of their bearings. This imposes a hardship on the manufacturer of machinery when his volume of machines will not warrant the making or purchase of special drills, reamers and gages.

For the most part, the bearings listed in millimeters are either too tight or too loose a fit in a standard hole in the fractional system. We have decided against using ball bearings on various occasions because it would have meant a boring job instead of one of drilling and reaming and having a bearing just fit our holes.

To be sure it would be a costly job for the bearing companies to change entirely over to our system, but I doubt if the foreign business will compensate for the inconvenience and cost that the use of the metric system imposes on the small American manufacturer. Why wouldn't it be a good idea for the American bearing manufacturers to make their products suitable for American use?

LLOYD A. WHITTAKER, *Engineer*
Thomson-National Press Co.

Reducing Clamping Difficulties

To the Editor:

UNLESS the designer is careful, clamping means may evolve into one of the most complicated mechanisms on the machine. A way to overcome this is shown in the accompanying illustration, a simple stationary ring which may be used for actuating work-clamping members in a rotary feed table mechanism. Shown here as adapted to the holding of short lengths of shafting on end and traversing them past a cutter or grinding wheel, it is of course adaptable to the handling of any kind of small work simply by designing the clamping members and the work recesses in the revolving table to suit. The table is shown as *A*, revolving around stud shaft *B*, and carrying two pivot mounted, work-clamping members *CC*. In actual use there will be as many clamping members around the circumference of *A* as can be conveniently arranged, but these two suffice to illustrate the principle.

Eccentric ring securely clamps materials in position during processing

Ring *E* is rigid and stationary, and is mounted somewhat eccentric to the revolving table *A*, thus forming eccentric channel *D* in which the work-clamping members ride. The loading and unloading position is shown at *H*, where it will be seen there is plenty of room to push lever *F* well back toward the ring to allow of unloading and loading. As the device continues around in the direction of the arrow, channel *D*, continually narrowing, comes into engagement with lever *F*, clamping the work progressively tighter against revolving table *A*. As the contact point of the lever reaches point *G* maximum tightness is obtained, and it is at this point that the oper-

ation on the work is performed. A dwell may or may not be arranged at this point, depending upon the nature of the operation

That portion of the lever at *J* is machined to a dimension calculated to bring the compressive force of the mechanism to the desired degree, the lever flexing at *J* to some extent as it passes point *G*. Thus, it will be seen that any desired degree of tightness may be obtained without a great deal of difficulty.

—JOHN E. HYLER,
Peoria, Ill.

Insuring Adequate Lubrication

To the Editor:

IN THE May issue of MACHINE DESIGN I noticed a letter from John E. Hyler, Peoria, Ill., in which he stated that there are several important problems to be considered when a shaft is lubricated by drilling. Mr. Hyler is correct in assuming that the freer the running fit of one bearing the more the lubricant will be admitted to that bearing and taken away from the tight-fitting bearing. This is, of course, providing the area of the drilled hole in the shaft is not greater than the area of all of the outlet holes. The area of this drilled hole should exceed the total area of outlet.

Let me explain further. It is obvious that the resistance to oil flow decreases as the bearing clearance increases, all other factors being constant. And unless restrictions are placed in the path of flow, the bearing with the greatest clearance will get the most oil when one central drilled hole is feeding a number of bearings, each with its individual line from the center hole. Proper proportioning of the size of openings from the central drilled hole to the bearings will eliminate the necessity of using restricting devices such as chokes or drip plugs. The total conducting area of the outlets or submanifolds should be less than the area of the main manifold. With this proper proportion no difficulty will be experienced from tighter bearings not getting the proper amount of lubricant as there will always be a surplus amount of lubricant in the center drilled hole which will suply the increased demand of the freer bearings and still leave sufficient lubricant to supply the tighter bearing with all of the lubricant required.

Individual feed channels leading to each bearing mean an economic disadvantage.

—ROBERT G. N. EVANS, *Research Engineer,*
Bunting Brass & Bronze Co.

Determining Engine Horsepower

To the Editor:

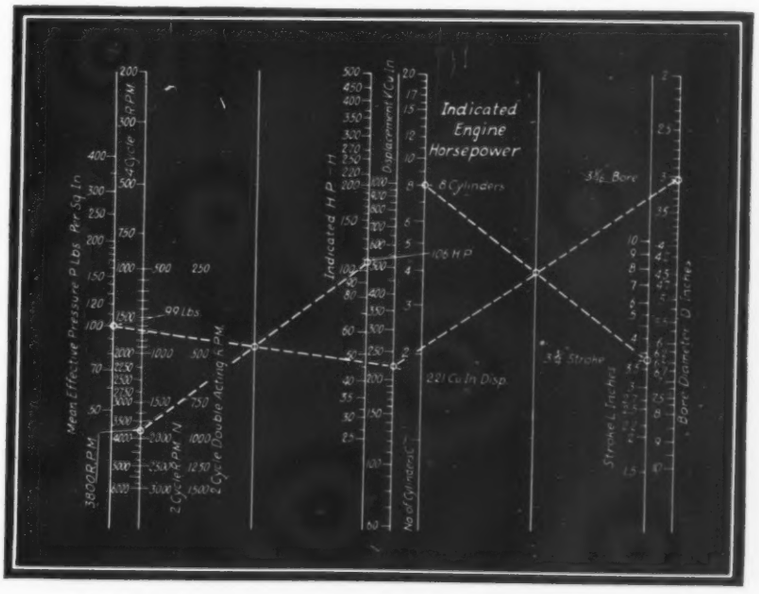
FOR USE as a simplified means of determining the indicated horsepower for a four or two-cycle engine, or for calculating the displacement of these engines, I would like to offer the accompanying nomogram. The condensed formula for the four-cycle engine is

$$H = \frac{CLD^2PN}{1{,}010{,}000}$$

However, the chart is made in intermediate steps so as to make the displacement a turning scale, which is graduated. With the displacement given, only the left half is needed.

The dashed lines in the right half of the chart show that the Ford V-8 having 8 cylinders 3-1/16-inch bore by 3¾-inch stroke has 221 cubic inches displacement. Left half shows that at 3800 revolutions per minute with a mean effective pressure of 99 pounds the indicated horsepower is 106. A mechanical efficiency of 0.85 was assumed.

—CARL P. NACHOD, *Vice President,*
Nachod and U. S. Signal Co. Inc.



Nomogram provides a simplified means of determining indicated horsepower of a four or two-cycle engine

MEN of MACHINES

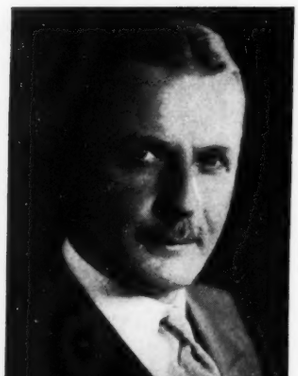
ON JULY 1, Prof. Herman Diederichs becomes dean of the college of engineering at Cornell University, following the retirement of Dean Dexter S. Kimball. Long recognized as an authority on experimental engineering and engineering materials, Professor Diederichs in 1928 became first holder of the John Edson Sweet professorship of engineering.

At the age of fourteen he came to New York state from Germany and within four years learned English, graduated from high school and won a state scholarship to Cornell University, where he graduated in 1897 with an M. E. degree. Although he had partly to work his way through, he won scholastic prizes, the Sibley fellowship for graduate study and success in athletics.

Professor Diederichs is chairman of the board of honors and awards and of the nominating committee of the A.S.M.E.

HERMAN DIEDERICHS

• • •



ACHIEVEMENT of executive success by following the path of engineering, was the method by which Alfred Kauffmann arrived at the presidency of Link-Belt Co. Beginning with the company as a draftsman thirty-five years ago, Mr. Kuffmann was promoted shortly afterward to be designing engineer. Later he served as sales engineer and as superintendent of construction for the company.

Stepping over to the executive side, he became manager of the Link-Belt plant at Philadelphia, then was made manager of the Dodge and Ewart plants in Indianapolis. For the past four years he was first vice president in charge of operations in Chicago. He has been a director since 1922, and as president he now resumes a responsibility which he carried from 1924 to 1932.

ALFRED KAUFFMANN

• • •

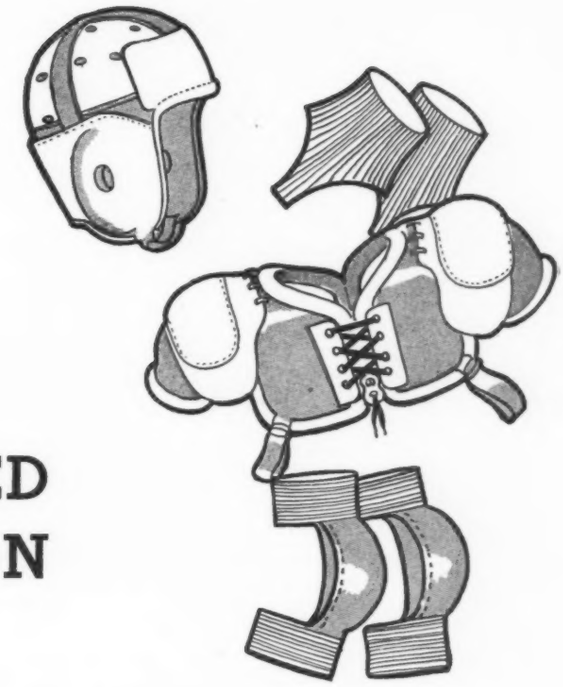
WITH a background of twenty years of design and general engineering experience, Guy Hubbard this month takes up new duties as associate editor of MACHINE DESIGN. For the past year he has been engaged in consulting work, primarily with Cone Automatic Machine Co.

Mr. Hubbard is extremely well qualified to interpret technical development in the machinery building field. His earlier training included specialization in machine design at New Hampshire State College, as well as ten years in the engineering department of Windsor Machine Co. and their successors, National Acme Co.

During the war he served with the Ordnance department spending most of this time on erection, testing and operation of

GUY HUBBARD

Courtesy Frank Moore Inc.



CORD SETS . . .

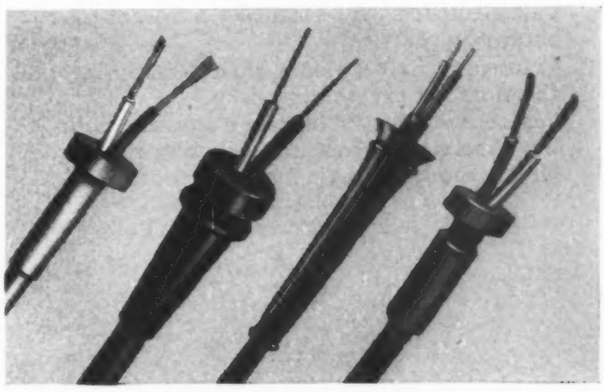
LIKE ATHLETES NEED STRAIN PROTECTION

G-E STRAIN RELIEFS ARE MOLDED ONTO THE CORD

Every athlete guards against muscle strain as expertly as possible. Ankle protectors, knee protectors, shoulder pads, etc., are all used to keep the player fit and in the game. In the same way, good cord-protecting strain reliefs on appliance cord sets keep the appliance efficient and "on the job".

General Electric rubber cord protectors are molded directly onto the cord. Tough—resilient—they relieve damaging strain on terminal connections. They protect the cord at important points where trouble is apt to occur. G-E molded rubber strain reliefs are designed to make it easy to connect the cord set to your appliance.

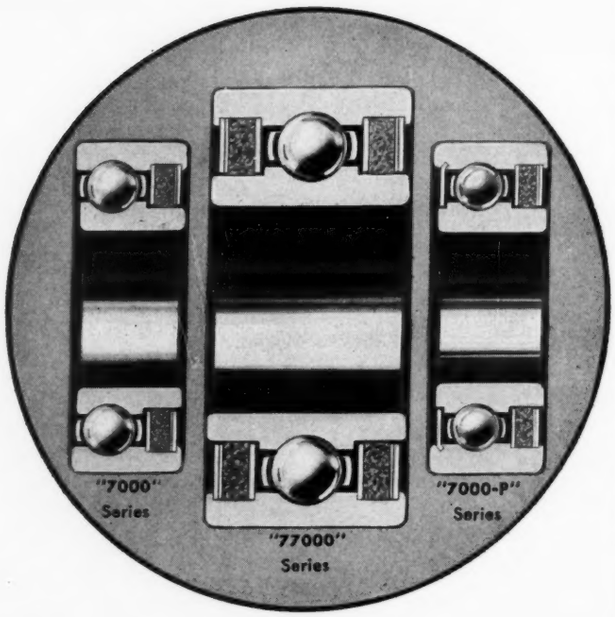
In short, these G-E cord protectors prolong the useful life of every appliance. May we show you a cord-protecting rubber strain relief *molded on the cord* for your product? For samples, complete information, or help in solving unusual strain relief problems, write Section Q-146 Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.



GENERAL ELECTRIC

ACCESSORY EQUIPMENT

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONN.



SELF-SEALED

Norma-Hoffmann "GreaSeal" Felt-Protected PRECISION Ball Bearings have the following outstanding advantages:

Thick, closely-fitting felts between removable plates, forming an effective labyrinth against recessed inner ring.

FELT SEAL REMOVABLE in its entirety, for inspection, cleaning, or renewal of grease.

Wide inner and outer rings, with maximum contact on shaft and housing, make inserts in housing unnecessary and militate against slippage, looseness and escape of lubricant past outer ring.

Felt seal entirely within confines of both rings; therefore not exposed to injury.

Seal construction avoids race distortion, assuring dimensional exactness and quiet running.

Grease capacity ample for long periods.

Write for the Catalog. Let our engineers work with yours.

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST
NORMA-HOFFMANN BEARINGS CORP'N., STAMFORD, CONN., U. S. A.

high pressure equipment in United States nitrate plant, Muscle Shoals. His experience also includes six months with the National Recovery administration in Washington on the preparation of capital goods codes, and later the handling and exchange of engineering data, prices, etc., for the machine tool and forging industry, in which he is an authority. Five years editorial work with the American Society of Mechanical Engineers and The Penton Publishing Co. (to which he now returns), together with his wide engineering background, fit him excellently for his new post.

♦ ♦ ♦

CHARLES A. CHAYNE has been promoted to the position of chief engineer of Buick Motor Co., Flint, Mich. Prior to joining the Buick organization, Mr. Chayne was with Lycoming Mfg. Co. and Marmon Motor Car Co.

♦ ♦ ♦

CHARLES F. KETTERING, vice president and research director, General Motors Corp., has been awarded the John Scott Memorial award for scientific achievement.

♦ ♦ ♦

DR. E. F. LOWRY, formerly research engineer with Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed director of research and development for Continental Electric Co., St. Charles, Ill., manufacturer of photoelectric cells, and electronic and special vacuum tube devices.

♦ ♦ ♦

FRANK B. POWERS succeeds the late CLAUDE BETHEL as manager of the railway engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh. Mr. Powers who is a graduate of the University of Illinois, attended the engineering and design schools of the Westinghouse company and has had wide experience in the field of heavy electric traction.

♦ ♦ ♦

SOL EINSTEIN, chief engineer of Cincinnati Milling Machine & Cincinnati Grinders, Inc., has been elected a vice president of the company. Starting as a tracer 33 years ago, he reached the position of chief engineer in 1920.

♦ ♦ ♦

GEORGE W. BURRELL, president, Wellman Engineering Co., has been elected president of the Cleveland Chamber of Commerce. Mr. Burrell began work at the age of 16 as an apprentice machinist at the Cleveland Rolling Mill Co., later studying mechanical engineering for three years at Ohio State university. He started with the Wellman company in 1898 as a draftsman.

♦ ♦ ♦

JAMES L. WICK JR. has been elected president of the American Foundrymen's association succeeding DAN M. AVEY, editor of *The Foundry*, who was president the past two years. Mr. Wick, president and general manager of the Falcon Bronze Co., Youngstown, Ohio, since 1925, graduated in mechanical engineering from the Massachusetts Institute of Technology. In 1906 he began work with the Youngstown Sheet & Tube Co., and within two years was appointed assistant to the chief engineer of that company.

♦ ♦ ♦

C. W. MEYERS has been appointed development engineer of the American Steel & Wire Co., with his headquarters in the Rockefeller building, Cleveland.

♦ ♦ ♦

PETER P-G. HALL, president, Hall Planetary Co., Philadelphia, has been awarded the Edward Longstreth medal by the Franklin institute, in recognition of his invention of the planetary system of milling and threading.

BUILD IN A COUNTER TO BUILD UP *Sales*

When a prospect asks, "*What can we expect from your machine?*", you can tell him *exactly*—quote actual performance figures that can't be questioned—if your machines are equipped with built-in Veeder-Root Counters. Builders of elevators, typewriters, tractors, presses, trucks and many other products are increasing sales with counters . . . *and so can you.* There are Veeder-Root devices for measuring and recording speeds, lengths, volumes . . . for counting pieces, operations, trips, starts and stops . . . for calculating and computing in dollars and cents . . . for making permanent records and printing receipts. Let's get together. Veeder-Root engineers will work with you in strictest confidence, without obligation. Write.

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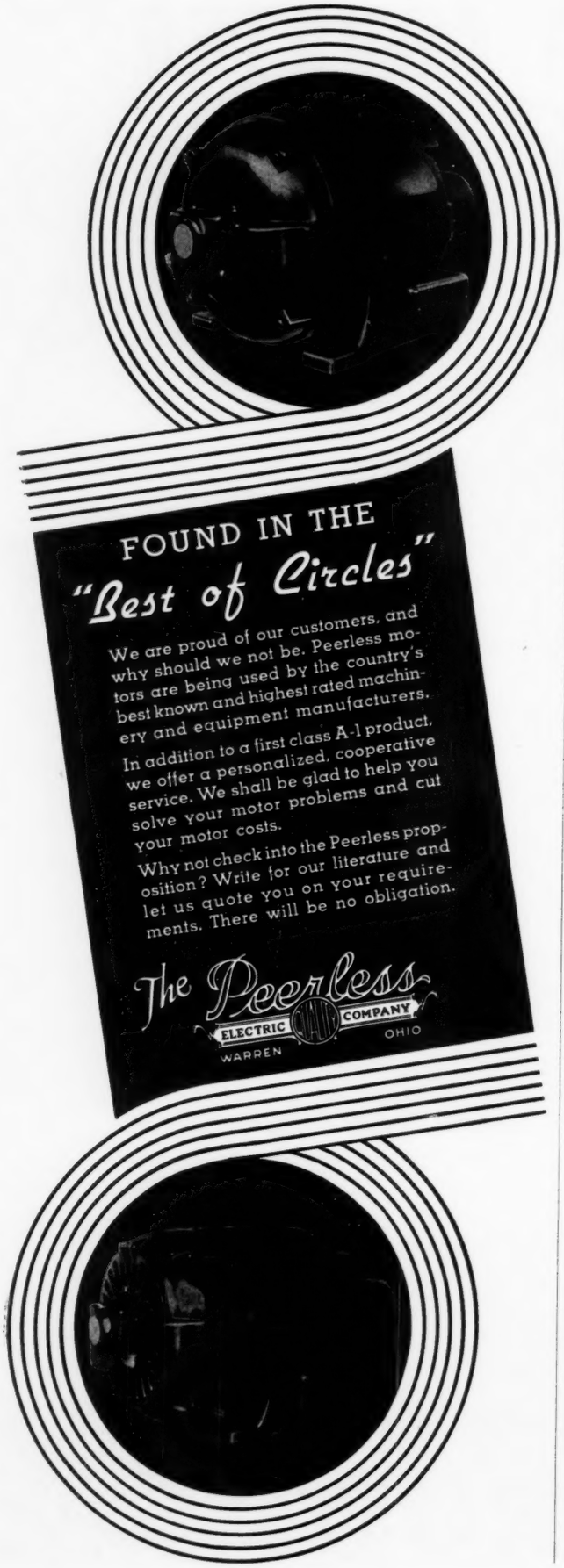
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"Best of Circles"
We are proud of our customers, and why should we not be. Peerless motors are being used by the country's best known and highest rated machinery and equipment manufacturers.
In addition to a first class A-1 product, we offer a personalized, cooperative service. We shall be glad to help you solve your motor problems and cut your motor costs.
Why not check into the Peerless proposition? Write for our literature and let us quote you on your requirements. There will be no obligation.
The Peerless
ELECTRIC COMPANY
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OHIO

Noteworthy Patents

AN INVENTION conceived by Samuel E. Diescher for Diescher Tube Mills Inc., Pittsburgh, incorporates an arrangement for supplying cooling water to the interiors of rapidly rotating guide disks while in operation, and also for the escape of either steam or highly heated water in order to dispose of such heat as may be necessary to retain the guide disks within a predetermined maximum temperature. Details of the mechanism are shown in drawing *X*, *Fig.* 1. The mill illustrated comprises a pair of cross rolls *A* and *B* having their axes inclined to each other and to the line of feed of a blank between them. Disposed between the cross rolls and on opposite sides of the pass between them is a pair of adjustably mounted grooved guide rolls or disks *C* and *D*, arranged on horizontal axes and adapted to be driven in any suitable manner as by wobblers, not shown. In the pass between these two pairs of rolls is shown a cylindrical mandrel *E* within a tubular blank *F*

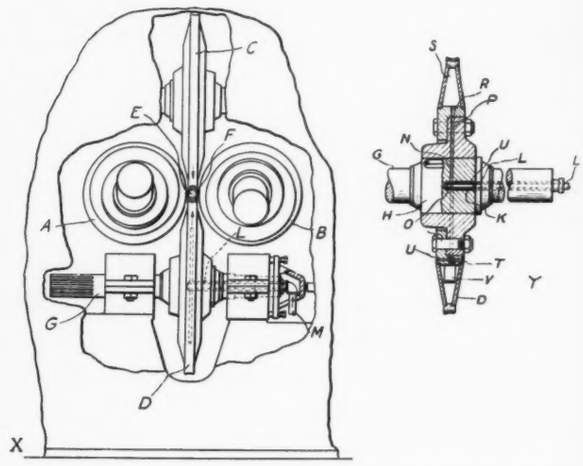

Fig. 1—Water-cooled guide disks eliminate effect of heat in the rolling of tubes

undergoing reduction in wall thickness and elongation by the combined action of the rolls.

As illustrated in detail in drawing *Y*, *Fig.* 1, shaft *G* is provided with an enlarged cylinder portion *H* to constitute a seat for guide disk *D*. Bore *J* has a lining tube *K* of brass or other suitable material within which is a feed pipe *L* preferably of steel for supplying water to the interior of the disk. Feed pipe *M*, drawing *X*, is connected to the outer end of pipe *L*. Pipes *K* and *L*, drawing *Y*, which rotate relatively to each other, have a close fit to minimize seepage. Shaft *G* has eight radial holes or passages *N* in the same plane as openings *O*. The aligned pas-

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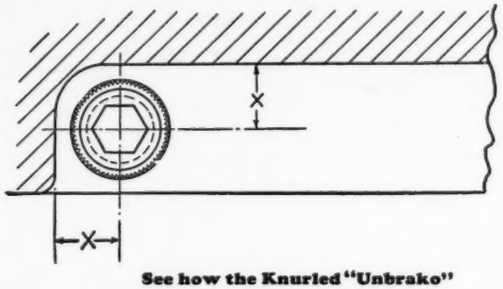
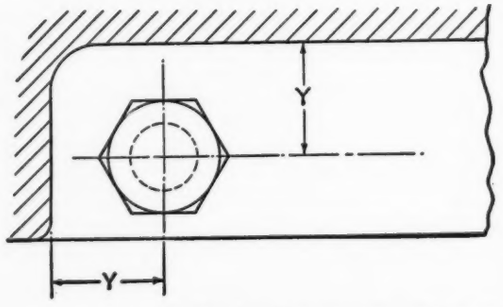
PATS. PENDING.
KNURLED "UNBRAKO"
SOCKET CAP

KNURLED UNBRAKO for COMPACT DESIGNS



See how the Knurled "Unbrako" snuggles right into the corner.



Notice the great open spaces necessary for the hex-head and wrench.

The difference between "X" and "Y" in line cuts demonstrates the decided saving in Clearance, Material, Weight and Cost made possible by using the Knurled "Unbrako" Socket Head Cap Screw.

Don't pooh! pooh! these advantages as they may help to make difficult designs easier and much more compact.

The Knurled "Unbrako" is the only Socket Cap Screw with a Knurled head; furthermore, the only one that can be locked and that will save time in assembling.

Be sure to get our complete and interesting "Unbrako" Bulletin No. 485.

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Branch Offices and Warehouses
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sages *N*, *P* and *R* constitute the inlet for cooling water into the annular chamber *S*. Outlet for the chamber *S* comprises a short radial hole *T* extending from the chamber radially inward to connect with a transverse passage *U*, the ends of which are open to the atmosphere. Baffles *V* prevent water from flowing directly from chamber *S* into openings *T* when the guide disk is in motion.

Heat from the rim and wall members passes to the water in the chamber. In case steam is generated it will collect on the inner surface of chamber *S* because the water is thrown outwardly by centrifugal force. Steam will flow outwardly through outlets *T* and *U* and escape into the atmosphere.

Number of the patent is 2,034,284.

AN EXPANSIBLE cylindrical sheath serves to prevent the escape of gas or liquid from one side of a bearing to the other in a pump or compressor seal recently patented by E. R. De Luiz. This sheath or bellows-like member *A*, *Fig.* 2, has one end hermetically sealed to collar *B* and the other end to a sealing ring *C*, which for convenience of assembly is made of two threaded parts preferably constructed of so-called self-lubricating metal. Spiral tension spring *D* presses sealing ring *C* against the hardened margin of casing *E*. For the purpose of oiling the bearing and seal a spiral oil groove *F* is provided to carry lubricant from the interior of the casing through the bearing and into the cavity *G*. An oil relief port *H* leads from this cavity back to the interior of the casing to permit escape of excess lubrication. Apex Electrical Mfg. Co., Cleveland, is the assignee of the patent, identified as No. 2,025,815.

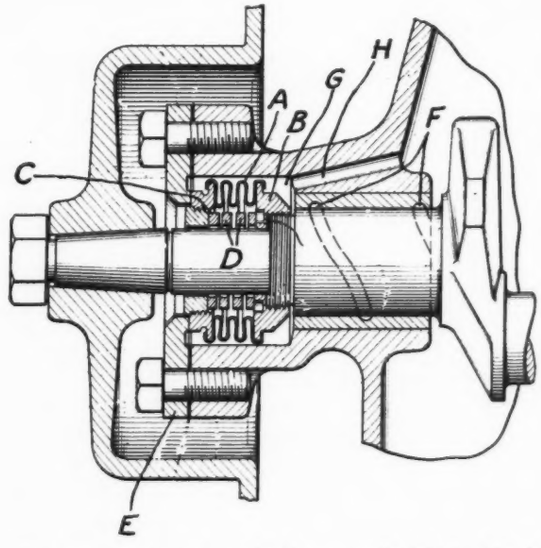
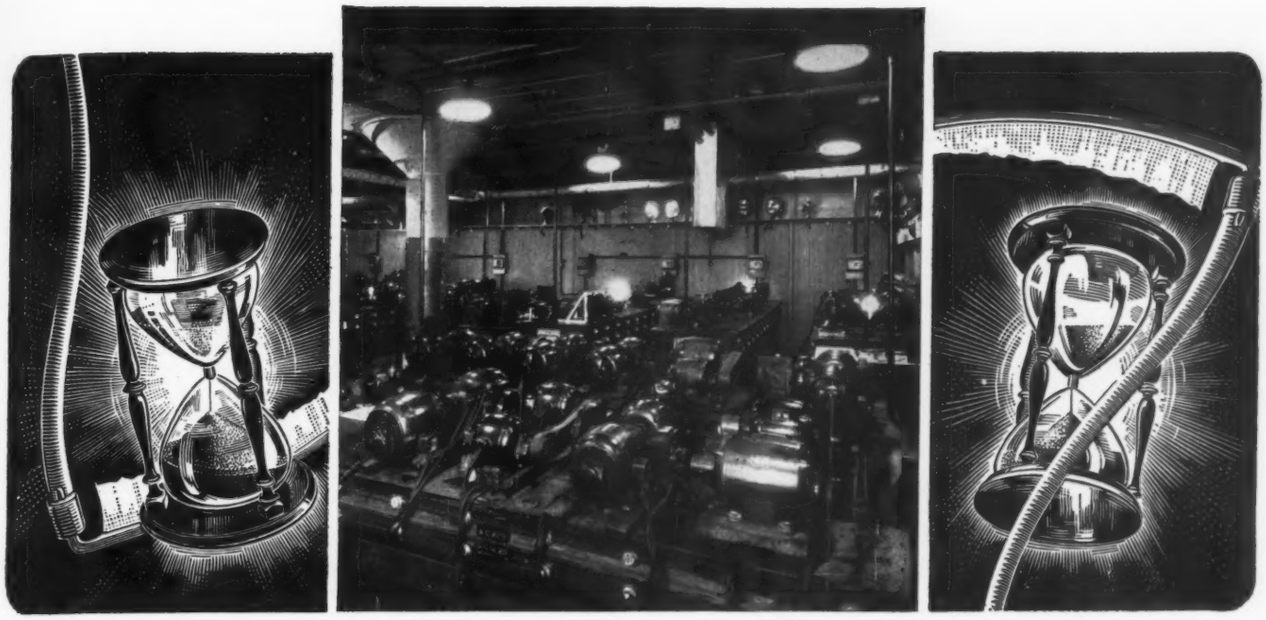


Fig. 2—A seal that embodies a cylindrical sheath prevents escape of gas or liquid



Performance

PROVED BY HUNDREDS OF TESTS

In this room Emerson Engineers deliberately run Emerson Motors to destruction—to learn *how well* and *how long* they will operate under every conceivable operating condition.

A 49,000-hour endurance run back of one and 27,370,000 starts behind another—with none of the parts in either motor showing signs of appreciable wear—just two Emerson Motors taken at random from regular production.

Tests of materials used—hundreds of tests on parts as production progresses—*plus* the "death sentence" for at least one of each new type of motor *after* it has been assembled—not only to make certain that Emerson Quality has been maintained, but also to provide the opportunity for raising the standard of "Emerson Quality" to even higher levels.

That's why Emerson Motors have established such enviable service records—why Emerson Motors built 20 and more years ago are still giving satisfactory service.

If built-in stamina, quietness, and freedom from attention are demanded of *your* motor-operated equipment, by all means investigate Emerson Motors. Write for Bulletin 52M.

THE EMERSON ELECTRIC MFG. CO.
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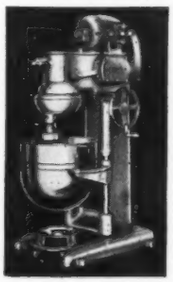
CENTURY BAKERY EQUIPMENT

Built by The Century Machinery Co., Cincinnati, Ohio — and Powered by Emerson Motors.

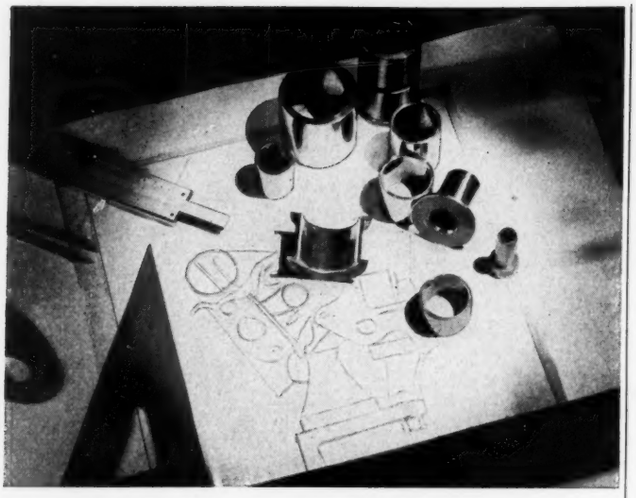


The growing preference of bakers for Century mixing, dough conditioning and loaf moulding machines, can be attributed to the reputation for dependable performance that this equipment has won over a long period of years. All have permanent mesh transmission—automatic lubrication—roller bearings, and spiral cut gears for silent operation and long life. Also, they are equipped with totally enclosed, quiet, cool-running Emerson Motors—individually-engineered to withstand heavy overloads, necessitated by the viscosity of materials handled by Century equipment.

EMERSON ELECTRIC

MOTORS — FANS — APPLIANCES

LEADERS IN THE FAN AND MOTOR INDUSTRY SINCE 1890



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Johnson Bronze can give you the correct answers to all of these questions. Our staff of competent engineers and metallurgists will study your applications from every angle. Loads will be determined, speeds, shock, impact or end thrust. The wear rate in relation to the expected bearing life. Unusual factors, perhaps, such as acid, corrosion, operating temperatures.

Regardless of the conditions that exist —our more than 25 years exclusive bearing experience—plus the most complete and versatile facilities available —enables us to recommend the exact type of bearing to deliver the maximum in performance.

Our counsel is offered without obligation —our recommendations entirely without prejudice. May we be of service to you?

JOHNSON BRONZE
525 S. MILL STREET • NEW CASTLE PENNA.

Simplifying Controls with Bimetal

(*Concluded from Page* 36)

developed by Spencer Thermostat Co. for use in connection with space heaters. In this device the crimped saucer-shaped bimetal disk A is housed in an open cage allowing free circulation around it of the air in the room. This element is set so that when the air in the room reaches a predetermined temperature, the disk snaps downward, thus seating bleeder valve C.

Remote Control Is Simple Matter

This causes gas pressure to build up in the chamber above diaphragm D, which closes the main gas outlet to the heater. Remote control can be arranged by having the thermostat and diaphragm units separate, and connecting them through small copper or aluminum tubing instead of by the self-contained ducts shown in the cut. Another successful application of the bimetal disk is in the Spencer relief valve for hot water storage tanks. These elements have to be immersed in the hot water, which in some parts of the country has been found to corrode the bimetal. To protect the disks without affecting their sensitivity, they are hermetically sealed in envelops of thin sheet copper.

The corrugated tube or bellows type of bimetal element also is useful in the direct operation of valves, especially in cases where gradual opening and closing over a considerable range is called for. This shape of element is in effect a multiplication of "U" section rings each of which contributes its share to the total throw of the bellows, which is considerable in relation to the space occupied by the element.

Transformer Made Self Protecting

Self-protected electrical transformers are made possible by the use of bimetal elements immersed in the oil within the case. In a Westinghouse transformer of this type, the bimetal thermostat is made to serve a dual purpose. First, when the oil becomes dangerously hot a lamp is switched on which illuminates a red bull's eye in the front of the case. If this warning is ignored, the thermostat further acts to trip the breaker in the secondary circuit before burning-out temperature is reached.

The foregoing examples are merely "a drop in the ocean" in relation to the innumerable uses to which bimetal is put. They are, however, indicative of the general method of application, and show the potentialities of this composite product.

Motors that master the air are made more dependable with NICKEL

FREE Send for our handy celluloid vest pocket size "Hardness Conversion Table." Quickly gives approximate relation between Brinell, Rockwell and Shore hardness values and corresponding strengths of Nickel Alloy Steels. Address Dept. L-6

The fact that Nickel Alloys are almost universally used by the aviation engine industry, may be considered a guide to their value in all machinery subjected to hard service.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

NEW Materials and Parts

Coating Aids Corrosion Resistance

ZINC, widely used alone and as a protective coating because of its corrosion inhibiting properties, can be given additional protection for extreme cases by use of a recently patented process, the Cronak process, developed by New Jersey Zinc Co., 160 Front street, New York. The process is a visible protective coating commercially applied to zinc or cadmium, and zinc or cadmium coated metals. Besides materially reducing the corrosion rate, this coating prevents the formation of white corrosion products where they would otherwise form.

The method of producing this film involves a short immersion in an inexpensive solution of sodium dichromate and sulphuric acid in water. The film gives the metal an appearance not unlike brass, with a greenish-brown iridescence. An immersion of from 5 to 10 seconds will produce a brown coating on zinc alloy die castings. A shorter immersion from 1 to 5 seconds produces a lighter iridescent coating. The color and its corresponding weight of coating is a direct indication of its protective value. Tests indicate that the process extends the life of zinc coatings by at least 40 per cent. Use of the process is allowed under license agreements.

Starter Extinguishes Arcs

LINESTARTERS employing the De-ion principle of arc interruption in a complete new line have been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Designed for across-the-line starting for single phase and polyphase squirrel cage induction motors and as primary switches for wound rotor induction motors, they are especially applicable where pushbutton control is desired with complete protection to the operator, the motor and the machine.

Motor protection is provided by a thermostat disk overload relay. A proper inverse time characteristic prevents shutdowns due to temporary overloads. Also, protection is assured against single phase and locked rotor operation. Heaters for operating the disk are interchangeable and easily accessible. The relay can be arranged for either manual or automatic reset. The entire assembly of the compact unit, shown herewith, can be removed from the cabinet by loosening one screw which clamps the steel base in place against rubber pads. Vertical straight-line operation of the contactor prevents accidental closing.

The arc box is a heavy one-piece noncarburizing porcelain section with openings to permit inspection of contacts without stopping production. The De-ion arc quencher confines, divides and extinguishes the arc almost instantaneously and without the usual flash and attendant scattering of the flame. This not only gives unusually high arc rupturing ability but also assures long life of the contacts.

Arc quencher confines, divides, and extinguishes the arc almost instantaneously and without the usual flash and attendant scattering of flame

---

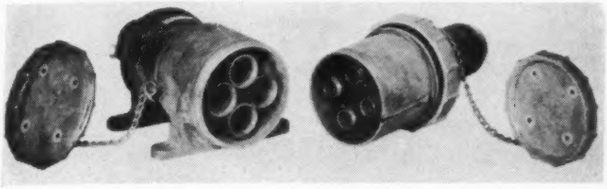
Introduces Cable Couplers

FOR USE on high voltage cable applications, General Electric Co., Schenectady, N. Y., is offering a newly designed coupler. These couplers can be used to provide a satisfactory method to connect apparatus and to connect lengths of portable cable together. The couplers, which are rated at 100 amperes, are particularly adapted for use with GE 2500, 3500 and 5000-volt, types SH and G, portable cables. Provision is made in the coupler socket so that shielding tapes or ground conductors of the cable can be brought out for grounding purposes.

Both the socket and plug are equipped with a cover to prevent the entrance of dirt and moisture when the coupler is disconnected. Socket and plug are made of a malleable iron frame with malleable iron end bell bolted on. The current carrying contacts are of the sliding spring type and are enclosed and shielded by tubing. There are four contacts, three of which are for the individual conductors of a

three-conductor cable; the fourth contact is for the shielding braid or ground wires.

Another development of the company is a molded rubber terminal which is applied in cases where it is desirable to terminate portable or drag cable at the source of energy or at the load by means of a terminal which will hold the single conductors firmly together as a unit. The terminal is made of tellurium compound and provides means of terminating ground wires and braided shields so that they can be correctly grounded.



Couplers are designed for use on high voltage cable applications to connect portable cables

Cold Rolled Steel Is Stabilized

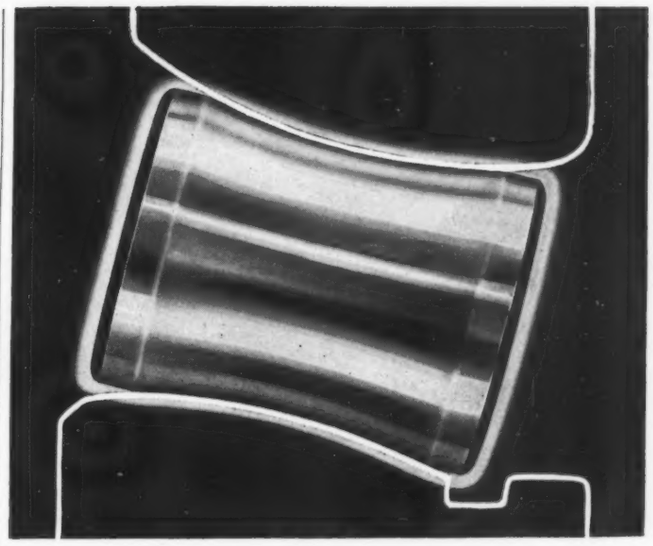
FULL commercial production of "Armco Stabilized Steel" in cold rolled sheets and strip has been announced by American Rolling Mill Co., Middletown, O. Stabilized steel is offered by the company as a uniform, deep-drawing and nonaging cold rolled steel with all stretcher strains permanently eliminated in the tempered condition. It retains all of the properties of temper-rolled steel indefinitely, making prefabrication treatments unnecessary, regardless of the length of time the metal has been in stock.

Unlike ordinary mild steels for deep drawing purposes, the new metal has no sharp yield point in the temper rolled condition. It is superior in resistance to cracking in some very severe drawing operations, and it will retain its initial drawing properties indefinitely, the company claims.

Couplings Are of Gear Type

GEAR type flexible couplings in two distinct designs, the medium duty and the torque ring, have been brought out as an important addition to the coupling line manufactured by John Waldron Corp., New Brunswick, N. J. The medium duty type, shown herewith, incorporates the conventional double engagement principle. It is designed to function on prime or second movers on all classes of equipment, as well as simply transmitting power in the small bore range of 1 to 3½ inches inclusive.

The torque ring type employs the patented principle of quadruple engagement. It is rugged,



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4. Economical application, in simple mountings not requiring precise installation.

Investigate the value of these advantages to you.

Available in a full range of sizes: Pillow Blocks, Flange Units, Cartridge Units, Take-up Units, Duplex Units, Hanger Boxes, Conveyor Rolls, Radial-thrust Roller Bearings. Write for Catalog 12-A.

SHAFER BEARING CORPORATION
6513 West Grand Avenue - - - Chicago, Illinois

SHAFER
SELF-ALIGNING ROLLER BEARINGS

Keep
SPECIAL
ROLLED
SECTIONS
in mind

IN designing parts to be turned out on a quantity-production basis, it is well worth while to view them in the light of bar-mill capabilities. Often it happens that the design can be adapted to manufacture from special rolled sections.

Bethlehem pioneered this type of steel product and has rolled a wide variety of difficult sections. If a section can possibly be rolled, it can be rolled in the Bethlehem Bar Mills.

So great are the savings sometimes realized by the use of special rolled sections that we suggest a careful review of the parts of your product with an eye to this economical method of manufacture.

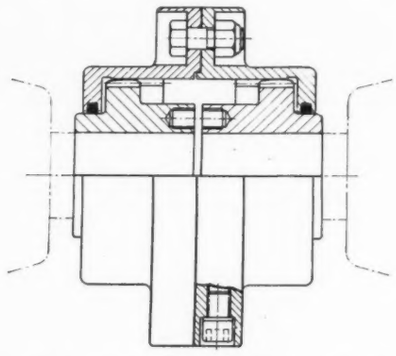
BETHLEHEM STEEL

Bethlehem Steel Company
General Offices: Bethlehem, Pa.

Bethlehem District Offices are located at Albany, Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Honolulu, Houston, Indianapolis, Kansas City, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, Portland, Ore., Salt Lake City, San Antonio, San Francisco, St. Louis, St. Paul, Seattle, Syracuse, Washington, Wilkes-Barre, York. *Export Distributor:* Bethlehem Steel Export Corporation, New York

close coupled, finished all over and designed for the heavy duty, slow speed field. Maximum bores of stock sizes range from 4 to 12 inches inclusive.

Both types of these couplings take care of angular and direct off-set misalignment and a combination of the two, as well as providing



Improved gear type couplings have been brought out in two distinct designs

for free and independent lateral float of the connected shafts. They are made from high grade forgings throughout, except in the larger sizes where steel castings are used for the hub and sleeve only. The couplings will transmit their rated horsepower at high or low speeds or in reverse.

Valve Is Solenoid Controlled

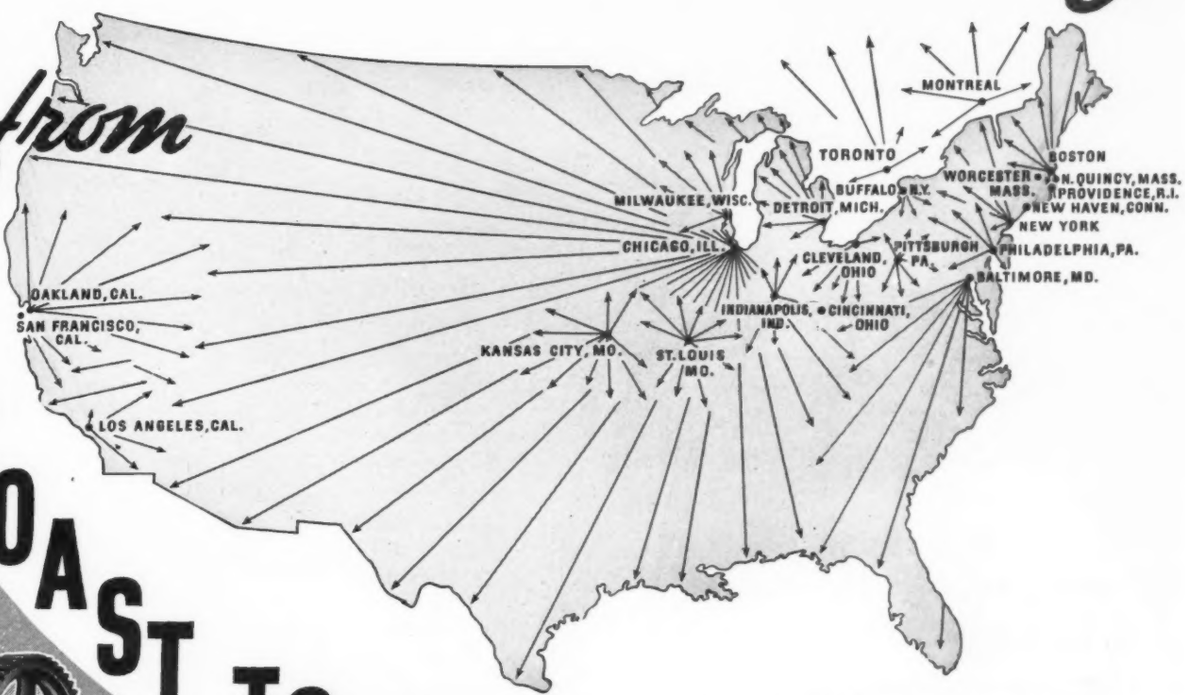
A NEW solenoid controlled straightway air valve particularly intended for the severe service of production plants has been introduced by Ross Operating Valve Co., Detroit. This valve,

Solenoid valve intended for production plants may be used as a by-pass, tying in with other machine functions

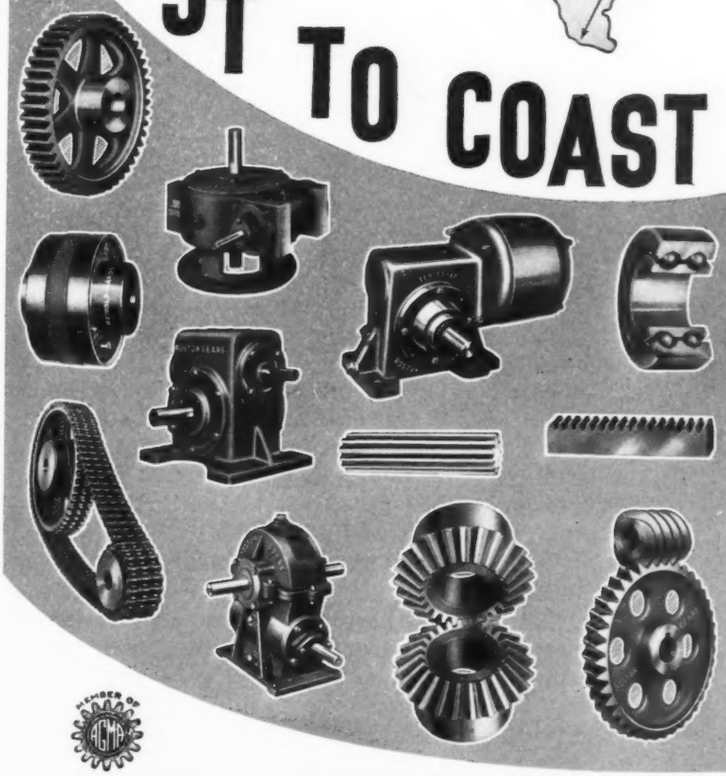
shown herewith, is of heavy and rugged design and is used, for example, as a by-pass, tying in with other functions where pressure in a cylinder must be regulated, a function which, of

Immediate Delivery

from



COAST TO COAST



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Immediate deliveries are made to all parts of the United States.

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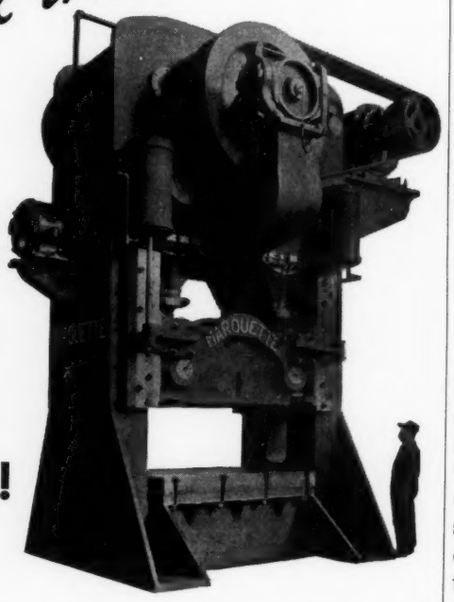
giving complete prices and specifications and listing all distribution points.

BOSTON GEAR WORKS, INC.
NORTH QUINCY, MASS., U. S. A.
A. T. & T. CO. TELETYPEWRITER CONNECTIONS

BOSTON GEAR
STOCK PRODUCTS

Go all the way



When You Design for Lubrication!

1 Select the proper material for the bearing conditions;

2 Provide sufficient area to support the load;

3 Design grooving correctly to insure proper distribution of lubricant;

4 Protect with adequate seals where necessary—*and also*

5 Provide the best method for supplying the bearings with the proper amount of lubricant at all times!

Unless a positive, dependable source of lubricant supply is available, the most careful consideration to materials, design, grooving, etc., will not prevent premature wear or even failure.

When you design for lubrication, *go all the way—include Farval!*

The Farval System is a mechanical method of delivering clean lubricant from a central station, under high pressure, to a group of bearings, in exact measured quantities, and at regular intervals. Its operation may be either manual or fully automatic.

By the Farval Method, frequency can be varied to suit conditions, but the performance is always constant and positive. No bearings can be missed; none can receive too much.

Design Engineers are invited to write for complete information and technical data. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

Special Delivery to Every Bearing

course, cannot be performed by an operating valve.

Other applications include the maintenance of constant fluid levels in tanks in connection with floats, and in welding machine operation where it is desired to move the piston in the air cylinder at a very slow rate of speed through low pressure, the piston (upon reaching the end of its stroke) exerting full line pressure through energizing the solenoid on the straightway valve. The new valve can be furnished for either normally open or normally closed service.

Provides High Heat Resistance

DESIGNED for applications where an economical combination of high temperature strength and oxidation resistance is required, the new "Silmo" steel of Timken Steel & Tube Co., Canton, O., may be used to replace carbon steel where greater safety is required and where oxidizing conditions are encountered. In the temperature range of 1000 degrees to 12,000 degrees Fahr., this steel is claimed to have about twice the strength of carbon steel and its oxidation resistance is said to compare favorably with that of 4-6 per cent chrome-molybdenum steel. Indicated uses for this new steel lie in the field of cracking furnace tubes, pipe still heater tubes, high pressure boiler and superheater tubes, and tubing used in the manufacture of air heating equipment.

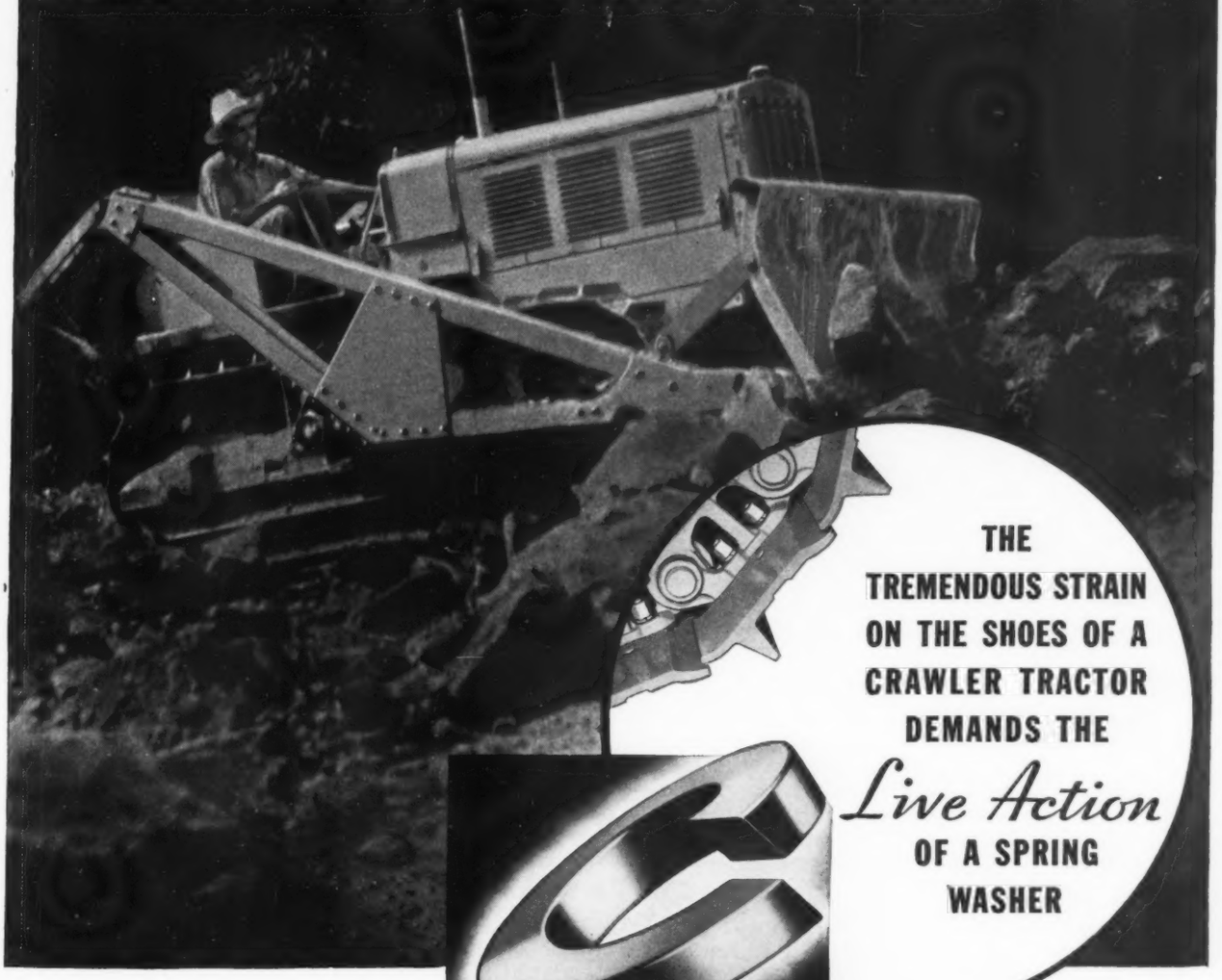
Announces New Industrial Motors

ESPECIALLY designed for heavy industrial duty, a new single phase repulsion-start induction motor has been brought out by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The new type CR motor, shown herewith, has high starting and pull-in torques which make it particularly suitable for such applications as pumps, compressors, machine tools, door openers, automobile lifts, car washers, grease guns, etc. It is available in a complete line of ratings, ¾ to 3 horsepower, 110/220 volts dual voltage for operation on all commercial frequencies.

The type CR motor starts as a repulsion motor and, because of the high torque developed, rapidly overcomes the relatively high inertia load to which this type of motor is usually subjected. At approximately 60 per cent of synchronous speed, the armature is short circuited by a centrifugally operated device, and the motor continues to operate as a squirrel cage induction motor. This results in a constant speed, irrespective of load.

The motor is essentially a heavy duty motor. All cast parts are of heavy section with shafts

WHEREVER THE JOB IS TOUGHEST..YOU'LL ALWAYS FIND A SPRING WASHER . . . .



THE TREMENDOUS STRAIN ON THE SHOES OF A CRAWLER TRACTOR DEMANDS THE *Live Action* OF A SPRING WASHER

The shoes of the crawler tractor, constantly moving and flexing, travelling over rough uneven ground and bearing tons of weight, stand a tremendous strain. The *Live Action* of Spring Washers keeps them secure because it compensates for play and looseness.

The *Spring Washer* is the only washer equal to the toughest jobs. Naturally, it is just as superior in simpler tasks.

ONLY A SPRING WASHER HAS *Live Action!*

SPRING WASHER INDUSTRY

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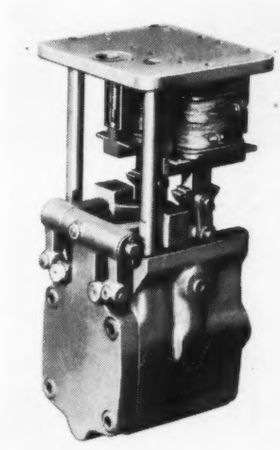
and bearings of liberal proportions. Mechanical and electrical features have been designed with the intention of producing a general purpose single phase motor that will give long life and

Recently introduced motor for industrial service has high starting and pull-in torques

trouble free operation even under the unfavorable operating conditions which frequently exist on applications where this type of motor is used.

Unit Simplifies Hydraulic Control

APPLICATION of hydraulic power feeds is considerably simplified by use of the new remote controller developed by Oilgear Co., 1319 West Bruce street, Milwaukee, which eliminates the need for mechanical control devices. With the unit, shown herewith, positive movement of the control valve plunger is provided by dual solenoid-operated pilot valves and a four-station cylinder compactly built into one unit, as shown, and flanged to the pump manifold. Energizing



Positive movement of control valve plunger in hydraulic transmission is provided by the remote controller shown herewith

and de-energizing the two solenoids intermittently or in unison through remote pushbutton stations or limit switches operates the pilot valves and selects the flow of oil to the control cylinder and the function required. The piston acts directly on the control valve plunger—no stems, oil seals or levers are required.

In addition, the company is offering a new

ITS COST IS 25% TOO HIGH

The operating mechanism of this bar-bending machine can be made from standard steel plate and bar stock by *"Shield-Arc"* welding. Of this construction, it would be 35% lighter; it would be more rigid, unbreakable and its cost would be 25% less.

Until this part is changed to *"Shield-Arc"* welded construction, it is guilty of wasting money every time it is produced!

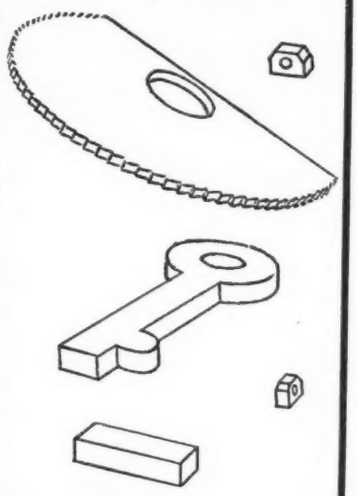
The odds are five to one that there is a base, frame, gear, lever, cover, container—or at least ONE PART in your product that can be improved or made at lower cost by *"Shield-Arc"* welding.

The Lincoln man nearby can point out those parts and show you the easiest and most economical way to change them one at a time to *"Shield-Arc"* welded construction. His services are yours without obligation. THE LINCOLN ELECTRIC COMPANY, Dept. C-265, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.

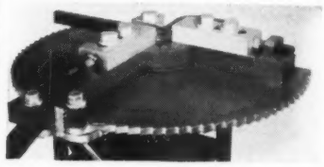
P. S.—The above part has been changed to "Shield-Arc" *welded construction. It is now 35% lighter, more rigid, unbreakable. And users report greatly simplified operation as compared to the old design. An improved product, built for 25% less money!*

Your machine may seem complicated, but it is simply an assembly of PARTS. One or more of these parts can be made BETTER at LOWER COST by *"Shield-Arc"* welding.

You can start now. Change one part at a time to *"Shield-Arc"* welded construction and thus reduce your costs and improve your product. Simply take standard mill shapes and cut them to proper size, like this—



Then assemble and fuse these shapes into a single unit by *"Shield-Arc"* welding, like this—



The Lincoln man nearby can show you how. He is at your service without obligation.

Photo courtesy of Wallace Supplies Mfg. Co., Chicago, Ill.

LINCOLN

"SHIELD-ARC" WELDING

THE LINCOLN ELECTRIC CO.
Dept. C-265, Cleveland, Ohio

Show me some Guilty Parts in our product. Show me how to make them stronger, lighter, at less cost by *"Shield-Arc"* Welding.

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Position .....

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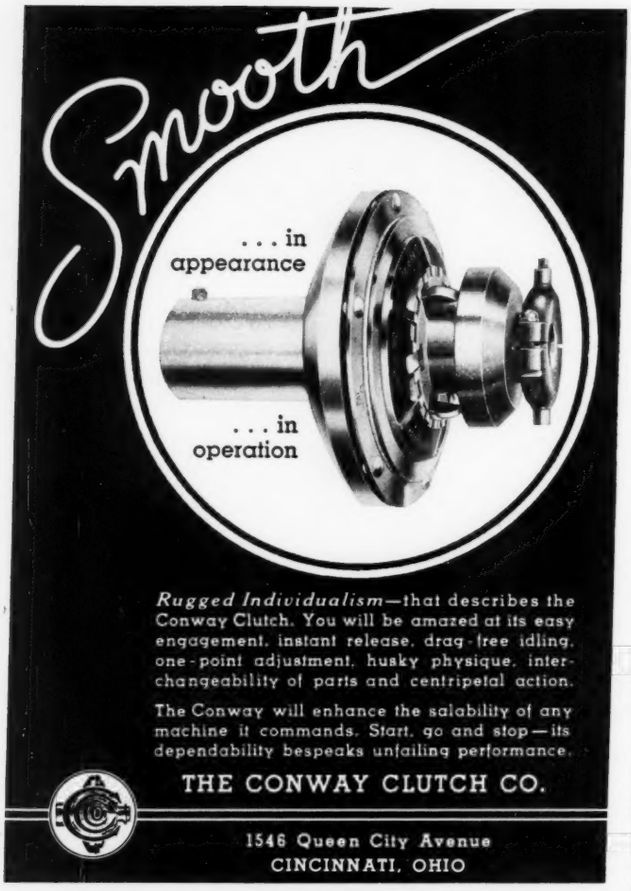
Smooth
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Rugged Individualism—that describes the Conway Clutch. You will be amazed at its easy engagement, instant release, drag-free idling, one-point adjustment, husky physique, interchangeability of parts and centripetal action.
The Conway will enhance the salability of any machine it commands. Start, go and stop—its dependability bespeaks unfailing performance.
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VARIATION
FROM ORIGINAL LENGTH 1/64"
it's a
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Spring performance like this is only made possible by a thorough knowledge of materials, temper and sound engineering methods. Your spring orders, too, will receive correspondingly good treatment if you send them to
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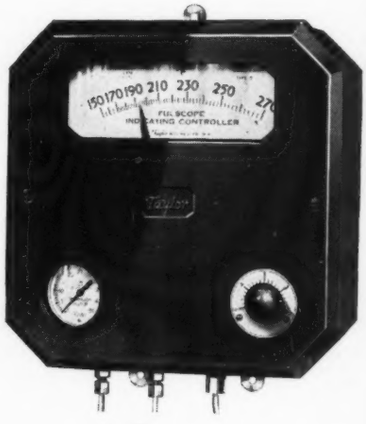
remote control for the fine feed pilot valve on the side of the pump. Another simple attachment provides remote control of the reverse function of mechanical control devices used in connection with feed pumps. An adjustable delayed reversal can be obtained when using this attachment and an electric time relay.

Controller Is Close Throttling

FOR the many processes where close throttling control is imperative but a record of the processing is not essential, Taylor Instrument Cos., Rochester, N. Y., has put on the market a highly adaptable air-operated controller of the indicating type, known as the Fulscope controller. High or full range sensitivity as required is available with the instrument, shown herewith, the former for processes having small time lags



Indicating controller will give close throttling for those processes where such control is necessary

and the latter for time lags of any magnitude. Both are fully adjustable by turning a graduated dial.

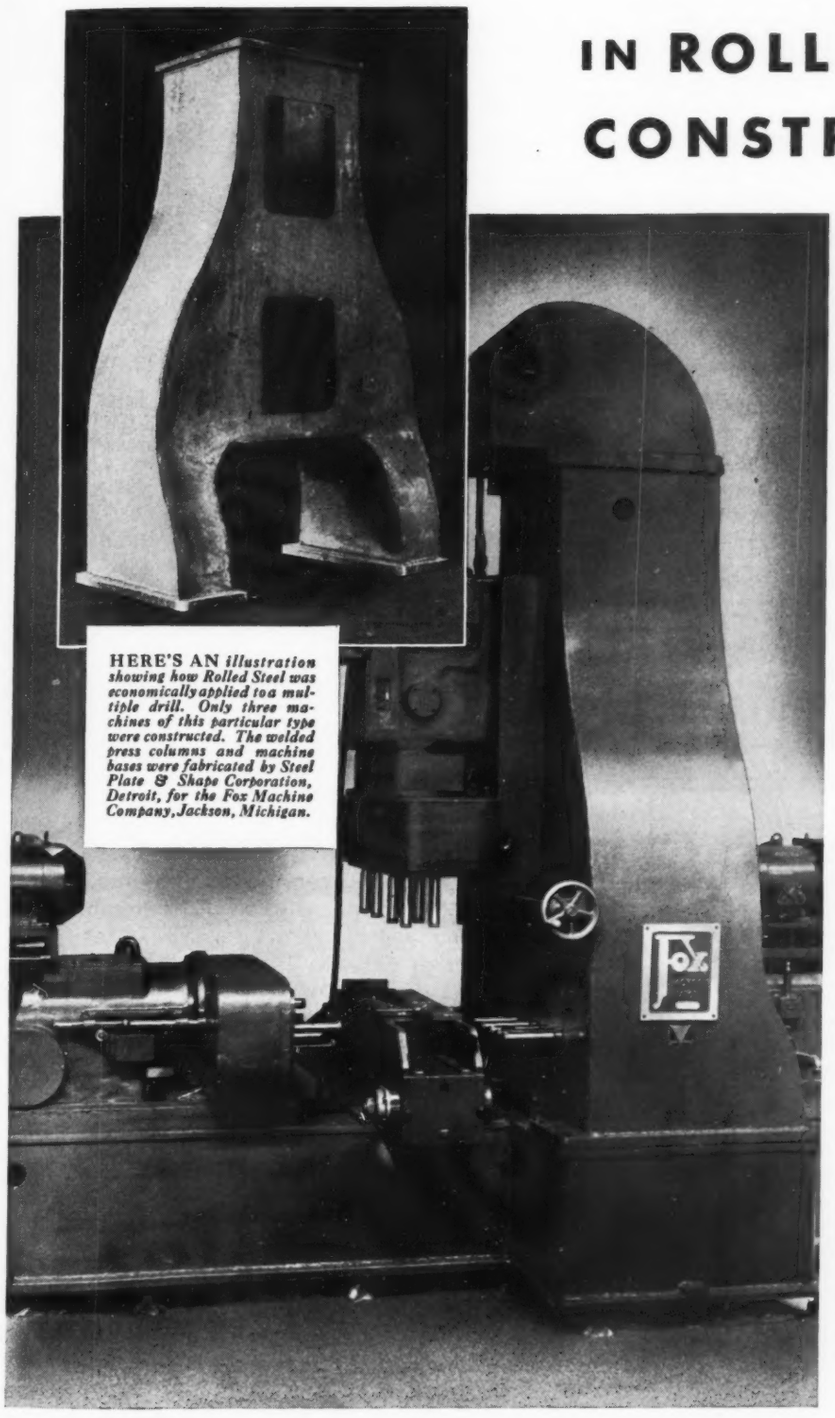
The control point may be adjusted to any value within the control range. Direct-set feature is optional. Controller action may be quickly reversed in the field by altering the position of a link. There are available many standard control ranges to choose from within the limits of minus 100 and plus 1200 degrees Fahr., or full vacuum and 3000 pounds pressure. Control ranges are interchangeable. Temperature controllers may be equipped with mercury, vapor or gas-actuated tube systems.

Improves Variable Speed Units

IMPROVEMENTS in infinitely variable speed drives recently developed by Lewellen Mfg. Co., Columbus, Ind., include an extended lever

There's new *freedom* for Designers

IN ROLLED STEEL CONSTRUCTION



HERE'S AN *illustration showing how Rolled Steel was economically applied to a multiple drill. Only three machines of this particular type were constructed. The welded press columns and machine bases were fabricated by Steel Plate & Shape Corporation, Detroit, for the Fox Machine Company, Jackson, Michigan.*

ASK any machine designer why Rolled Steel won his ready acceptance — why almost instantly it became popular throughout the machine tool field. He'll tell you quite a story.

He'll tell you, for example, that although its use was first confined to simple construction, Rolled Steel is rapidly becoming standard for precision machine tools as well. Why? Because the adaptability of Rolled Steel frees designers from old restrictions. Rolled Steel saves time and money by eliminating patterns, particularly when only a few machines are to be built. It gives designers known factors of strength to deal with. Stiffening and wearing members can be placed where needed. Excess weight and bulk can be discarded. Production costs cut. Time required for machining reduced. Cutting tool costs lowered. Quicker deliveries made possible. All of these advantages of Rolled Steel have created a new horizon for the machinery field.

In an amazing number of applications this modern manufacturing process has demonstrated its ability to produce a higher quality job, at lower cost, than any method hitherto employed. Why not investigate? Write for the new book "Rolled Steel for Machine Construction."

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
COLUMBIA STEEL COMPANY, *San Francisco*
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Use No. 8 VANE
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Ask for catalog on Geared, Vane and Centrifugal Pumps.

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— steady flow
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ROTATES WITH THE SHAFT

WRITE FOR IT—

This new pamphlet giving general information on the construction and operation of the ROTARY SEAL and showing various typical applications will gladly be sent at your request.

A mechanical device correct in engineering principles forming a perfect and permanent barrier against the passage of any liquid or gas along a rotating shaft.

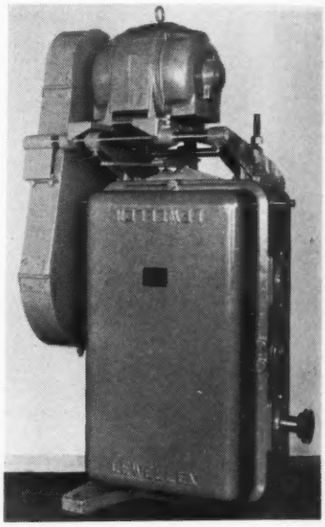
A radial type seal which automatically adjusts itself to take care of slight axial and transverse shaft movements and slight errors of alignment.

Time tested and proved in a wide variety of applications.

ROTARY SEAL CO.
General Offices
803 West Madison St. Chicago, Ill.

between the driving motor mounting and the vertical enclosed transmission, shown in the accompanying illustration.

On drives such as stoker drives a power cylinder connects to this extended lever to provide a method for automatically varying the coal feed with variation of the demand load and maintain a constant boiler pressure. This method of controlling speed is applicable for either automatic or manual operation by connecting the extended



Power cylinder can be connected to extended lever on variable speed transmission to maintain exact feeds to satisfy operating conditions

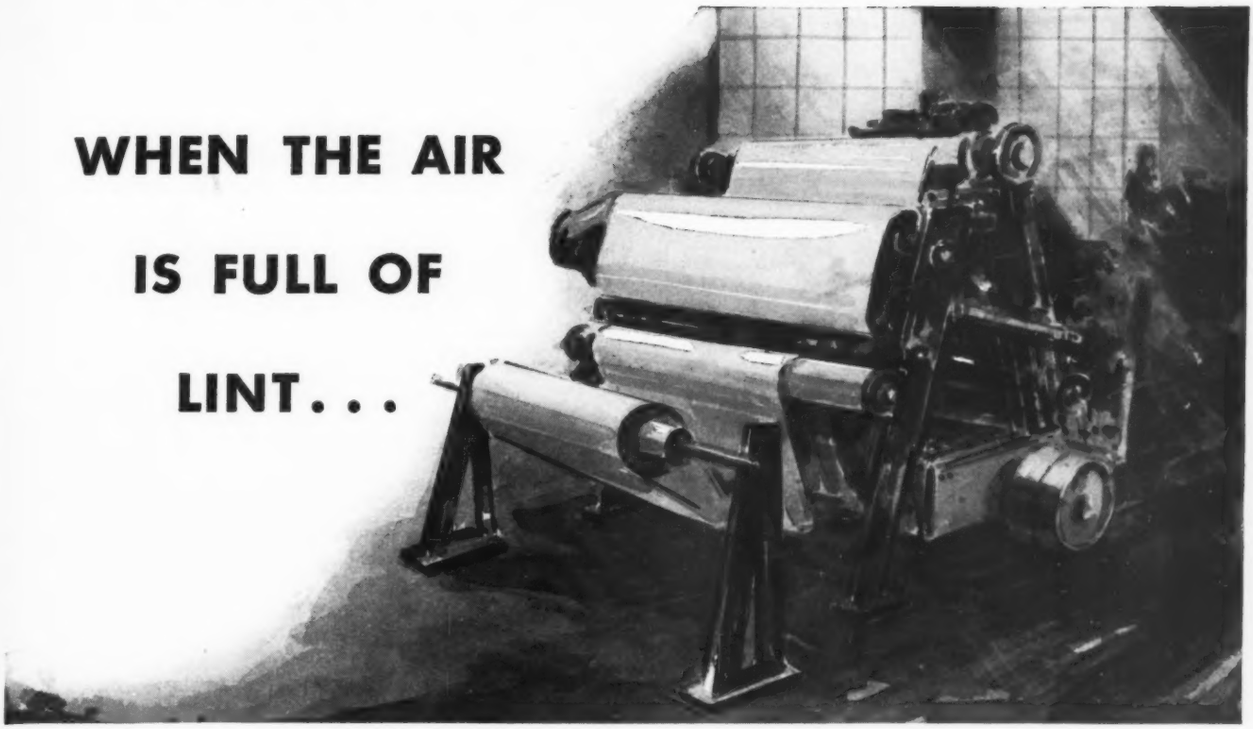
lever with any movable machine element, so that for any position a definite speed is obtained.

The lever lies close to the transmission and may extend in any direction. The construction is simple and efficient, and is applied to both the open and enclosed construction transmissions in both horizontal and vertical types. This design permits changing the range of speed variation of the transmission by simply resetting the stop for a new drive belt.

Conveyor Bearings of New Design

FOUR new types of protected bearings, each designed for a particular operating condition, have been developed by Standard Conveyor Co., North St. Paul, Minn. The bearings are for use in gravity conveyors and represent the latest designs in the grease-protected type. For use under working conditions where injurious dust is prevalent, a bearing has been designed with an inner and outer felt seal. Selected felt washers are used in front and in back of the ball race, sealing the gap between the inner and outer races.

To meet the demand for a grease-filled bearing which can be easily flushed and refilled with clean grease, a bearing has been designed which has a felt washer, supported by steel, built into



WHEN THE AIR IS FULL OF LINT...

KON-NEC-TORS

(Mercury-to-Mercury Switches)

Provide Switch Protection

This company built machines used in the textile industry to finish cloth. Had metal switches been utilized, a definite fire hazard would have existed. But totally-enclosed, glass-protected KON-NEC-TORS provided the instantaneous make-and-break contact that this machine's whirling blades called for, and also absolute insurance against lint, dust, and consequent danger of explosion.

Thousands of breaks a month or emergency contacts years and years apart—both conditions are ideally met by KON-NEC-TORS . . . They have indefinite life, as there are no parts to corrode or wear.

KON-NEC-TORS operate on low current, in complete silence. If your machine requires a dependable, trouble-free switch, you will appreciate further details on the KON-NEC-TOR. Address . . . General Electric Vapor Lamp Company, 825 Adams Street, Hoboken, New Jersey.

SINGLE POLE, SINGLE THROW MODEL

KON-NEC-TORS *provide designers with a wide variety of single and double throw type mercury switches, maintenance-free and dependable.*

GENERAL ELECTRIC VAPOR LAMP COMPANY

710K

Waukesha
METAL
"A Nickel Alloy"

WAUKESHA Metal is a corrosion-resisting, high nickel content, casting alloy especially adapted to use in fabrication of food handling equipment such as canning, baking, dairy, ice cream, beverage, distillery and brewery machinery.

Castings are nonporous, can be machined readily, will polish to a high permanent luster and can be cast from same patterns used for bronze or iron.

Made in various hardnesses and strengths for special applications.

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Booth
PRECISION CUT FELT

BOOTH FELT COMPANY, INC. 444—19TH ST., BROOKLYN, N. Y.

the rear of the bearing. This prevents the grease from working backward during the flushing process, while a steel shield in front has a sufficient outlet for the old grease to escape, but at all times is tightly sealed by grease to prevent the entrance of foreign matter. A third type has been designed to meet the requirement for all-steel protection. Where there is sufficient heat to affect a felt washer, the all-steel protection is more effective and flushing and filling with clean grease is practical.

The fourth type has a stationary outer steel shield to protect the bearings from molten metal, which would otherwise lock the roller and cause vibration to materials being conveyed. The flared shape of the shield throws foreign matter away. A collar of grease is left between the outer shield and the bearing when flushing the bearing.

Motor Design for Severe Service

DESIGNED for general industrial service, and particularly for use where abrasive and metallic dust is present or where splashing liquids and mild chemicals are encountered, a new line of fan-cooled totally enclosed direct current motors has been introduced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Sizes of the new SK motors, shown herewith,

Improved motor is especially designed for severe industrial service where dust or moisture is encountered

range from 5 to 75 horsepower for 115, 230 and 550 volts direct current.

The motors are so built that all foreign matter is excluded from the interior of the motor. The interior is also protected against the entrance of splashing water such as occurs during the hosing of floors or walls. With this new design, only one cover need be removed for making adjustment, and then it is no more trouble to examine the brushes or commutator than on a standard enclosed motor.

This design has a distinct advantage that permits mounting the pulley or pinion close to the supporting bearing. Also, the motor may be mounted close to a gear box at the pulley end without interfering with the free flow of venti-

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Again, National Industrial Advertisers Association presents a national conference designed not only to help industrial companies to solve many of their sales and advertising problems, but to point the way for heavy industry to take its rightful place in American business. Prominent speakers will discuss:

The Importance of Heavy Industry in the Future of the U. S. A.

Industry's Public Relations Problem.

Improving Advertising through Better Company Organization.

The Place of the Agency in Industrial Advertising.

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Advertising Department Problems.

You can't afford to miss these meetings. Plan now to be there and bring MANAGEMENT with you. Register now; use the coupon.

October 5, 6, 7 — Benjamin Franklin Hotel, Philadelphia.

Heavy Industry to the Front!

MR. LOUIS A. CLEAVER,
F. W. Dodge Corporation,
1321 Arch St., Philadelphia, Pa.

Please find enclosed check for seven dollars, covering complete conference costs (including banquet and smoker).

Please reserve _____ rooms at Benjamin Franklin Hotel.

Name _____ Company _____

Address _____

Just as cooling ocean breezes increase the vigor of human bodies . . . . Roper Coolant Pumps increase the efficiency of metal working machines.

There are Roper Coolant Pumps of all types for handling cutting compounds and lubricating fluids on metal working machines. Write for Bulletin R4MD.

ROPER PUMPS

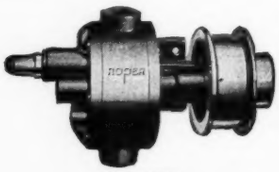


Fig. 4210

GEO. D. ROPER CORP., ROCKFORD, ILL.

Test!

The best test of our ability to supply "*better fibre parts, at less cost*", is to let us show you samples of parts fabricated from Wilmington Fibre . . . and to let us quote on parts for that new product.

It's a test that will pay you dividends . . . yet, a test that requires but a few moments of your time. A request on your company letterhead will bring samples and a copy of our treatise on fibre and fibre fabrication to your desk. Or send us specifications for a particular part to get our quotation.

No obligation, of course.

"Wilmington Fibre"

WILMINGTON FIBRE SPECIALTY COMPANY

PIONEERS IN FIBRE FABRICATION — WILMINGTON, DELAWARE

lating air. The flexibility of this construction also permits adaptation, with some modifications, for waterproof and explosion tested applications.

Pressure Switch Is Improved

A NEW pressure switch for automatic control of small compressors and fluid pumps has been announced by Cutler-Hammer Inc., 1310 St. Paul avenue, Milwaukee. This switch, shown herewith, is featured by all-metal "air-styled" enclosing case; flexibility of application; full automatic action; protection of motor; and ease of wiring, adjusting and inspection of the switch.

Pressure connection for SAE fitting is furnished as standard, but can be converted into ¼ or ⅜-inch pipe fitting. Inverse time limit overload protection is obtained by a eutectic metal thermal overload relay, operating directly on the contact mechanisms. The relay gives protection to the motor during starting and running, and allows an ample time interval to take care of starting inrush and momentary overloads without tripping. A red band on the reset button indicates when the switch is open and the equipment shut down; pressing the button resets the overload, placing the starter back in service. By simply pulling out the reset button the equipment can be shut down whenever this should be necessary.

Pressure switch controls small compressors and fluid pumps automatically, and has extreme flexibility of application

Finishes Are Heat Resisting

DESIGNED particularly for machinery and similar industrial purposes, a new metal finish of unusual properties has been introduced by Asphalt Products Co., Grand Central Terminal, New York. Although it is of a modified asphalt base, the finish has characteristics different from the usual finishes of this type. The new products, known as Aspro metal finishes, are obtainable in black and the darker shades of gray, red, green and brown. They show re-

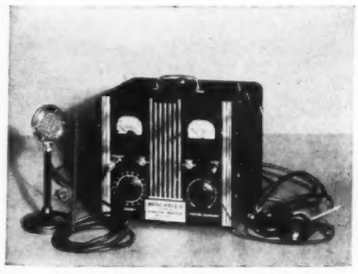
sistance to the destructive reagents commonly encountered in industry. They are insoluble in oil and the lighter distillates of petroleum. Caustic and other alkaline solutions, cutting compounds, alcohol and most of the acids in commercial use are said to have no effect on these finishes. They are highly resistant to water, sunlight and heat (temperatures up to 400 degrees Fahr. do no damage to them).

The finishes may be applied by air gun or brush and may be air-dried or baked. They dry to the touch in four hours and attain maximum hardness in twenty-four hours. They have a smooth, glossy surface yet have sufficient resiliency to prevent checking, cracking or peeling, and elasticity that permits expansion and contraction with changes in temperature. These finishes are non-fire-supporting and when submitted to extremely high temperatures, merely smolder without bursting into flame, thus giving unusual protection.

Engineering Department Equipment

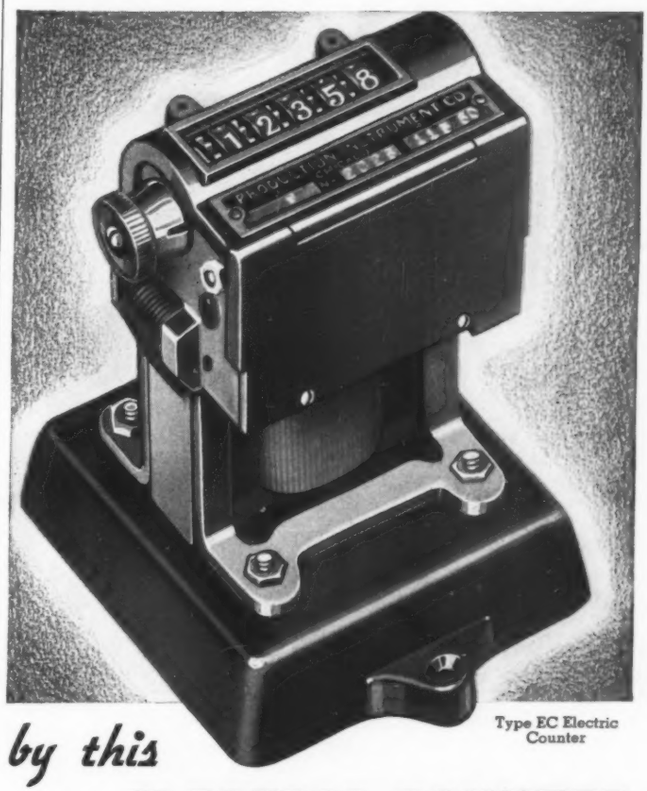
Indicator Gives Sound Levels

A NEW sound level indicator, designed to measure sound levels exactly as heard by the human ear, has been announced by Industrial Apparatus Co., 720 North Wabash avenue, Chicago. With the instrument, shown herewith, the user can secure accurate data on sound and noise levels, thereby reducing testing steps necessary. In addition to the ability to produce equipment with a uniform noise level, the instrument aids the design engineer in noise level reduction work. The indicator consists of a calibrated crystal type microphone, an audio frequency amplifier with all-metal tubes, a calibrated attenuator, an ear weighing network, a decibel meter and a crystal type headset. The range is from thirty to ninety decibels, ASA standard. Although designed for alternating current operation, batteries may be used for operation.



Sound levels exactly as heard by the human ear are measured by new sound level indicator

Even the **"UNTOUCHABLES"**
are accurately counted



Type EC Electric Counter

by this
ELECTRIC COUNTER

★ Freshly painted, or fragile, or soft articles which cannot be counted by a mechanical counter may still be accurately counted anywhere in the process of production by the use of the Type EC Electric Counter, actuated by a simple photo-electric relay installation. Practically anything from light to heavy, large or small, red hot or frozen, can be made to yield accurate, dependable production records through the use of this Electric Counter and one of the wide variety of sensitive switches developed by Production Instrument engineers.

Type EC Electric Counters operate accurately and reliably at speeds as high as 25,000 per hour. Their small current consumption (6 watts) is of special importance with small contacting switches and photo-electric relays. They are ideal for remote control installations. Write for descriptive bulletin.

(Half actual size)

NEW PILOT SWITCH, Type ES-9 is an extremely sensitive and compact yet substantially built contacting switch, requiring only ½ ounce operating pressure. Easily installed anywhere, it is adapted to the widest variety of uses.

Write for bulletins with complete data on Electric and Mechanical Counters, Type ES-9 Pilot Switch, and other special-purpose switches.

PRODUCTION INSTRUMENT COMPANY
1319 South Wabash Ave., Chicago, Ill.
Accurate Counting and Recording Devices

Unbreakable Body.
Oil feed adjustment with shut-off switch.
Sight glass in shank to adjust oil feed to proper volume.
Self-closing hinge cover for easy filling.

Send for GITS Oiler Chart.

GITS BROS
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1861 S. Kilbourn Ave., Chicago

Roots
CONNERSVILLE

BLOWERS FOR . . .
OIL AND GAS BURNERS
FOUNDRY CUPOLAS
AGITATION AND AERATION OF LIQUIDS
PNEUMATIC CONVEYING.
PRODUCING PRESSURE OR VACUUM FOR OPERATING OTHER MACHINERY

GAS EXHAUSTERS AND BOOSTERS FOR . . .
GAS PRODUCERS
GAS MIXERS
PROCESS INDUSTRIES

ROTARY PUMPS FOR . . .
ALL LIQUIDS
VACUUM FILTRATION

ROTARY DISPLACEMENT METERS FOR . . .
ACCURATE MEASUREMENT OF AIR AND GAS

INERT GAS PRODUCERS

TOMORROW'S ENGINEERING APPROVED BY YESTERDAY'S EXPERIENCE

ROOTS-CONNERSVILLE BLOWER CORP.
CONNERSVILLE, IND.

MEETINGS *and* EXPOSITIONS

THROUGHOUT the winter, design rooms, laboratories and independent engineers work steadily at the never-ending job of increasing their knowledge of machines, mechanical phenomena and materials . . . . Interchange of information between them is chiefly through the medium of technical literature . . . . In June many of these men gather at a dozen scattered points . . . . Here to discuss their problems, disclose their findings, and prepare for another year of effort * * * Of foremost interest to designers are the various meetings of the American Society of Mechanical Engineers, such as the semiannual meeting at Dallas reported in these columns in the May issue . . . . Two other important meetings of this society are the applied mechanics division meeting at Pittsburgh and the oil and gas power meeting at Ann Arbor, Mich. * * * At Pittsburgh sessions will be held on vibration, creep and plasticity, elasticity and topics of general technical interest . . . . All of the information presented will be pointing the trend for design within the next few years * * * Oil and gas power is of growing importance . . . . Factors in this rapidly advancing development to be discussed will include high speed engines, fuel oil, metallurgy, high speed lubrication, gas engine development, bearings and speed regulation problems . . . . An exhibition of diesel engine parts and accessories is also planned.

Of additional interest to designers will be the Testing Materials meeting at Atlantic City . . . . Every designer must use a material in some form or another in every machine he builds . . . . This meeting will cover available information on many materials and enable many future design improvements * * * Corrosion, effect of temperature, and creep will also take an important place in this meeting with committee reports outlining latest discoveries . . . . These reports will cover iron-chromium, iron-chromium-nickel and related alloys; corrosion of iron and steel; corrosion of nonferrous metals and alloys; effect of temperature on the properties of metals * * * The iron and steel session will bring up to date data on cast iron, wrought iron, magnetic properties, and steel * * * Nonferrous metals are assuming an ever-growing place in the machine designer's concepts . . . . These valuable materials will be covered by discussions on copper and copper alloys, cast and wrought; light metals and alloys, cast and wrought; die cast metals and alloys; forming properties of some nonferous sheet metals; and the effect of the addition of lead on the endurance limit of a certain tin base bearing alloy.

The machine design profession will be advanced by the deliberations of the machine design division of Society for the Promotion of Engineering Education at Madison, Wis. . . . . Topics will include "Should Machine Design be a Required Subject for All Engineering Students," and "A

New Machine Design Laboratory" . . . . Another presentation will be a paper on "An Analysis of the Relation of the Helix Angle to the Efficiency of Worm Gearing."

June 6-Nov. 29—

Texas Centennial exposition. General display to be held at Dallas, Texas. Information may be obtained by addressing Frank N. Watson, Texas Centennial Central exposition, Dallas, Texas.

June 11-13—

American Society of Mechanical Engineers. Applied Mechanics division is to meet at Pittsburgh. Prof. E. O. Waters, Yale university, New Haven, Conn., is chairman of the division.

June 15-20—

American Society of Mechanical Engineers. Semiannual meeting to be held in Dallas, Texas. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

June 22-24—

American Society of Heating and Ventilating Engineers. Semi-annual meeting to be held at the Inn, Buck Hill Falls, Pa. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

June 22-25—

American Society of Agricultural Engineers. Annual meeting to be held at Stanley hotel, Estes Park, Colo. Raymond Olney, St. Joseph, Mich., is secretary.

June 22-26—

American Institute of Electrical Engineers. Summer convention to be held at Huntington hotel, Pasadena, Calif. H. H. Henline, 33 West Thirty-ninth street, New York, is national secretary.

June 23-26—

Society for Promotion of Engineering Education. Forty-fourth annual meeting to be held at University of Wisconsin, Madison, Wis. Frank L. Eidmann, Columbia university, New York, is chairman of the machine design division.

June 24-27—

American Society of Mechanical Engineers. Oil and gas power meeting to be held at University of Michigan, Ann Arbor, Mich. C. E. Davis, 29 West Thirty-ninth street, New York, is secretary of the society.

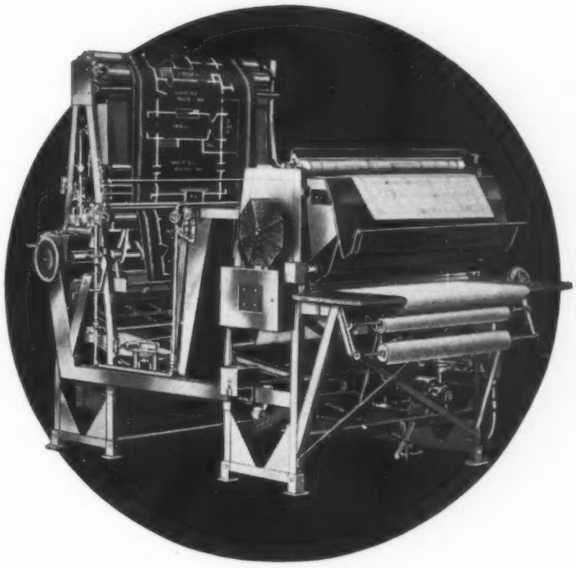
June 27-Oct. 3—

Great Lakes Exposition. General display including machinery and allied lines, to be held at Cleveland. Information on the exposition may be obtained from Lincoln Dickey, Great Lakes Exposition, Cleveland.

June 29-July 3—

American Society for Testing Materials. Annual meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. C. L. Warwick, 260 South Broad street, Philadelphia, is secretary.

Cut Your Blue Printing Costs With This Amazing New Machine!



PEASE MODEL "11" PRODUCES BETTER PRINTS FASTER AND MORE ECONOMICALLY

Right from the start, Model "11" took the lead in favor among users of continuous blue-printing machines. It is a "thoroughbred" in quality—a "champion" in results—yet, it is remarkably low priced, nearly $1,000.00 less than any other continuous blue-printing equipment on the market today.

Investigate for yourself! Prove to your own satisfaction just what Model "11" can do for you—how it will cut blue-printing costs and earn a profit for you by turning out high-grade prints up to a maximum printing speed of 12 feet per minute at lowest cost per square foot.

GET COMPLETE INFORMATION AND PRICES

Write now for this special pamphlet giving full information about Model "11" and how it can cut your blue-printing costs, along with special low initial purchase prices. Available in two sizes for paper either 42" or 54" wide.

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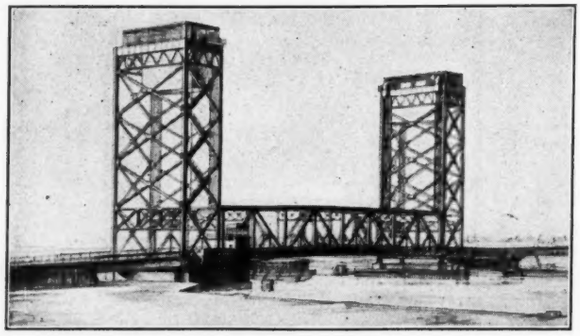
PEASE



Another Tribute to BANTAM!

THE Torrence Avenue Bridge, now being built over the Calumet River in Chicago, has a direct relation to your bearing problems—no matter what size you may use. Awarding the order to Bantam for eight roller bearings each weighing thousands of pounds to lift this span is just one more illustration of industry's confidence in us to solve difficult bearing problems.

A TIP FOR YOU

Take a tip from these bridge engineers, from the steel mills and the automobile manufacturers—all of whom are showing an increasing preference for Bantams for many uses. When you need bearings to do a big job, or when you need them to do a small job in a big way—*take your toughest bearing job to Bantam.* Our facilities and resourcefulness are doing the "impossible" for others. Perhaps we can do as much for you.

THE BANTAM BALL BEARING CO.
(Subsidiary of The Torrington Co.)
SOUTH BEND, INDIANA

BBB TAKE YOUR TOUGHEST BEARING JOB TO BANTAM

SPUR GEAR REDUCERS
(PLANETARY DRIVE TYPE)

• This type of reducer is sturdy, compact, durable, efficient, and is equipped with Timken Roller Bearings

The D. O. James Planetary Spur Gear Reducer is superior to any other type, having a gear arrangement that produces the highest possible gear ratio.

D. O. JAMES MANUFACTURING CO., 1120 W. MONROE ST., CHICAGO

D.O.JAMES

FOR ALMOST FIFTY YEARS MAKERS OF EVERY TYPE OF SPEED REDUCER AND CUT GEAR

Topics of the Month

(*Concluded from Page* 20)

overall time by eleven hours.

♦ ♦ ♦

Even though the Eastern railroads are protesting the fare cut, it is possible for the railroad design engineer to make such a cut an economic practicability by developing additional equipment which will operate at lower cost. Some equipment of this type is available, and the entire credit belongs to those progressive engineers who can visualize the possibilities of improvements.

♦ ♦ ♦

One of the most unusual sights ever to grace the post-depression, or even pre-depression, picture greeted the early visitor to the recent Foundry Equipment exposition at Detroit. For nearly an hour after the doors were opened, visitors were lined up for two blocks for the privilege of paying a dollar to register and to be given a chance to inspect the many new developments.

♦ ♦ ♦

Further refinement of design, more sturdy construction, ease of operation, centralized control, greater accuracy and speed featured practically all of the molding machines shown at this show. An interesting observation of a definite change in trend was noted. Emphasis at Detroit was placed on the types of equipment best adaptable to the medium or small jobbing foundry not engaged in repetitive work. With business heads finally recognizing the quickly-shifting changes in public acceptance and the necessity of meeting these changes just as quickly, machinery of this type should be prevalent in every field in the near future.

♦ ♦ ♦

A real need for a brief and simplified statement covering the production and properties of iron alloys in general, and especially the heat treatment of steel is filled by a recent bulletin of National Bureau of Standards. Particular attention is given recently-developed theories of the hardening of steel and the part played by special alloying elements.

♦ ♦ ♦

Improved alloying is not the only means by which cast iron is fighting not only to maintain but improve its position in the face of ever-increasing competition from other metals. The die casting or pressure casting of iron has become a commercial reality, with die cast parts produced which have considerably improved physical properties with the same chemical analysis as sand castings. Structure of parts made by this new process is unusually close grained while exceptional uniformity is maintained. Iron parts made by this process have such an unlimited use in the design of machinery that it would be an impossibility to even name over the fields. Do you want additional information on the process?

♦ ♦ ♦

Production of magnesium from sea water in a commercial process at South San Francisco gives promise of greater supplies of this element. As the available supply grows, the inherent advantages of this lightest of all metals can be

adapted more widely to all machines. Today magnesium is available as die castings, sand castings and rolled products to lighten any machine part regardless of the comparative scarcity of magnesium deposits.

♦ ♦ ♦

An enormous market, with untarnished virginity, is opening up for the makers of domestic machinery, water pumping equipment, and small tools. Rural electrification is being rapidly pushed in every section where there is sufficient population, with the government subsidizing the industry to the tune of over $500,000,000. Not a farm so wired for the first time has even so much as a vacuum sweeper or electric washing machine. It is up to the designer to create new and advantageous home and shop machinery which will enable his company to compete in what should be the largest and richest, albeit the most competitive, market ever opened for machinery at a single time.

♦ ♦ ♦

An interesting use of explosives in machinery is incorporated in a new tamping unit employed on recent dam construction. The ignition of a gas and air mixture in a single cylinder gasoline engine catapults a half-ton machine nine inches into the air, according to *Engineering News-Record*. The slope on the bottom of the tamper is so determined that at each jump the tamper moves forward away from the operator, and is thus ready for the next hop.

♦ ♦ ♦

Stainless steel has made possible another interesting machine, a unit which inaugurates a new type of predigested food. This machine converts citrus fruit into juice in such a way that it may be mixed with milk without curdling.

♦ ♦ ♦

Greater uniformity of materials produced on rolling mills is being realized through the application of a new device called a pressuremeter which gages rolling loads. In addition, the pressuremeter is designed to avoid overloading the mill and the consequent possible damage to equipment. By indicating and recording bearing pressures at the roll neck journals, maintenance engineers obtain accurate information as to the performance of the rolling mill. The gage utilizes the stretch of the housing as the means of actuating electromagnetic instruments.

♦ ♦ ♦

Vertically operated magnetic switches are used in place of the usual horizontal clapper type of magnetic switch on the elevators installed in the QUEEN MARY. Thus, the movement of the ship has no influence on the switch gear, which might be the case when meeting heavy seas if the clapper type were used. Now if they would just invent a way to make our interior entirely unconcerned about high seas, we might consider an ocean trip!

♦ ♦ ♦

Improved design in production machinery is accurately reflected in the pocketbook of every one of us. One field in particular gives a most accurate example of how design can reduce costs. The eighteenth major price reduction on electric light bulbs since 1921 has been announced within the last month. Not only are prices in this field coming down, but quality is going up. The other day we happened to uncover a bulb, in good working condition, that used to be the acme of quality just 15 to 20 years ago. Our young high school friends thought it was the funniest thing they had ever seen!

For their
"Push Button" Speed Control

LEWELLEN chose a

Bodine Motor

In the Lewellen variable speed transmission unit, built by the Lewellen Mfg. Co., a small pilot motor is used to change speed ratios. A push button or other pilot device operates the motor in a forward or reverse direction.

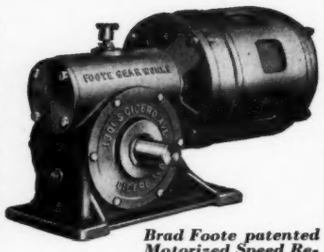
This pilot motor has to operate at very low speeds. As space is at a premium, it must be very compact. Reliability under frequent starting is essential. Then too, the unit has to be attractive in appearance. Lewellen engineers, after a careful investigation, chose the Bodine speed reducer motor as the unit best suited for their machine.

Bodine motors are to be found in hundreds of unusual and special machines. Such machines have widely different load characteristics and frequently require a motor "tailored" to fit their special needs. It is in such applications that Bodine motors and Bodine engineering have proved their value. The standard Bodine line includes practically every known type of motor. For over thirty years, Bodine engineers have specialized in adapting these motors to special jobs. They will be glad to help solve your motor drive problems. Write Bodine Electric Co., 2258 W. Ohio St., Chicago, Ill.

BODINE
FRACTIONAL H. P.
MOTORS
ENGINEERED FOR YOUR PRODUCT

EXPLOSION

proof motors may be removed from the reducer without disturbing the underwriters label, due to a patented feature in the method of mounting motor on reducer. This feature is used in all sizes and styles. It provides free floating of the motor shaft and eliminates the possibility of oil entering the motor.



Brad Foote patented Motorized Speed Reducer.

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FOR *Profitable* OPERATION

For the actuation of movements on multiple drills, broaches and other machine tools—for the operation of hydraulic lifts, elevators and road machinery—and for 1,000 other applications you will get PROFITABLE OPERATION out of the Viking Hydraulic Pressure pump.

VIKING ROTARY PUMPS

Incorporates Viking's Original "Gear Within A Gear—Just Two Moving Parts" principle as found in all Viking Rotary Pumps. Viking Hydraulic Pressure Pumps feature over-size driving shaft and two extra-large anti-friction bearings. Made of laboratory-tested metals—in capacities of 5 to 45 G.P.M. Write for complete list of applications, specifications and prices.

Viking Pump Company
Cedar Falls, Iowa

Are Your Ideas Patentable?

(*Concluded from Page* 26)

that ordinarily involved in applying clutches to machines.

There are several corollaries growing out of the foregoing "Negative Rule". One of these corollaries is that it does not constitute invention to substitute *superior* for *inferior* materials. Another corollary is that to produce an article which is different from some older article only in excellence of workmanship is not invention. Thus, for example, if it had been customary to make an article of unpolished material, it does not involve invention to polish it. Nor is it invention to plane a board by machinery, producing a smoother finish than that produced by hand. However, in these cases the machinery itself may be the subject matter of a patent.

Look for the New Function

In all cases involving these "Negative Rules" look for the *new function* produced. If you can successfully argue that there is a new function, you stand a fairly good chance in proving that your ideas are patentable.

There are many cases where it has been argued that commercial success of a device is an indication of its patentable merit. This is not necessarily true. Commercial success comes into play only where a *doubt* exists as to whether or not there is invention. If there is a real doubt, commercial success will generally cause the doubt to be resolved in favor of invention. The reason that commercial success cannot be used to prove patentable merit is that it is difficult to tell whether the commercial success was the result of merit of the device or the result of advertising or high pressure exploitation.

Articles on this and allied subjects published in previous issues of MACHINE DESIGN include:

"Careful Research Obviates Patent Pitfalls," March, 1933, p. 25, "Value of Patent Depends upon Efficient Claims," Aug., 1933, p. 13; and "Protect Your Right to a Valid Patent!" Nov., 1933, p. 24; all by George V. Woodling.

"Outstanding Patent Book Revised," Feb., 1934, p. 23.

"Patent Contracts Insure Legal Protection," April, 1934, p. 29; "Patents Should Be Prepared with Care But Without Undue Delay," July, 1934, p. 24; "Pitfalls Await the Unwary in Assigning Patents," Sept., 1934, p. 15; "Sales Value of Appearance Can Be Protected," Nov., 1934, p. 15; "Patent Infringement May Be Avoided by Careful Design," Jan., 1935, p. 22; "Trademarked Machines Increase Confidence of Purchasers," March, 1935, p. 30; and "Super-Inventing Is Function of Patent Department," May, 1935, p. 27, all by George V. Woodling.

"Is Our Patent System Weak?" by R. A. Perrett, Aug., 1935, p. 37, also by George V. Woodling, Sept., p. 66.

MANUFACTURERS' PUBLICATIONS

ALLOYS (STEEL)—Peter A. Frasse & Co. Inc., 17 Grand street, New York, has published a new 42-page booklet on the fabrication and treatment of USS stainless and heat resisting steels. The booklet is designed as a practical help to the engineer.

ALLOYS (STEEL)—How machines may be improved by the use of alloy steels manufactured by Bliss & Laughlin Inc., Harvey, Ill., is outlined in a recent bulletin of the company. The publication includes a partial list of popular grades of available alloy steels.

BLOWERS—Application of rotary positive blowers in foundry cupola service is covered in a bulletin of Roots-Connersville Blower Corp., Connersville, Ind. Complete details on the construction of the blowers are included.

BLOWERS — Janette Mfg. Co., 558 West Monroe street, Chicago, has issued a new bulletin on its line of motorized blowers giving characteristics of the blowers, a description, and other details of use when considering the application of these units.

CABLE—Complete data and listings of all types of tellurium all-rubber, Glyptal compound and braided types of portable cable for mining, welding and transit equipment, electric shovels and dredges, and similar apparatus are given in a new edition of the bulletin "Portable Cable" prepared by General Electric Co., Schenectady, N. Y.

CAST PARTS—Illustrations and descriptive matter covering the production and facilities, and methods of Shenango-Penn Mold Co., Dover, O., are presented in a new folder of the company.

COMBUSTION EQUIPMENT—Hauck Mfg. Co., 128 Tenth street, Brooklyn, has prepared a most complete data book on its line of oil and gas burning equipment. The catalog discusses fuel oil pumps, low and high pressure oil burners of several types, strainers, temperature regulators, valves, and other parts for use in automatic combustion machinery.

CONTROLS (ELECTRICAL)—Drum controllers of several types, details of construction, and typical applications are covered by a new bulletin prepared by Furnas Electric Co., 811 South Seventy-second street, West Allis, Wis.

CONTROLS (ELECTRICAL)—Complete details of the new compact pilot switch introduced by Production Instrument Co., 1325 South Wabash avenue, Chicago, are given in a folder of the company which includes construction, application information and other data.

CONVEYORS—Whitney Chain & Mfg. Co., Hartford, Conn., has published bulletin V-121 descriptive of its new line of open mesh conveyor chains which provide a uni-

There are many good reasons why Dumore fractional h.p. (series wound) motors differ from ordinary motors . . . why Users have found they deliver more "power hours" for the money. From drafting table to shipping room, each operation involves a little something extra, that pays dividends to the manufacturer that looks beyond appearance and price.

For example:-

1. **To assure longer brush life, commutator is ground concentric with bearings.**
2. **Armature leads are swaged to commutator by special Dumore process.**
3. **Forced ventilation assures cool, continuous operation.**
4. **Motor parts are inspected 5 times in manufacture.**
5. **Armature windings are pre-expanded, then sealed to prevent centrifugal "breathing".**
6. **Armatures are dynamically balanced on special Dumore balancing machine.**
7. **Every motor is actually "run-in" to seat the brushes.**

Dumore makes a complete line . . . 1/600 to ¾ h.p. . . . DC or AC, 0 to 60 cycles . . . the ideal drive for thousands of machines . . . husky shop grinders to fine jewelers' lathes . . . aircraft retractable landing gear to delicate telescope controls . . . all with smooth, dependable performance. The handy Dumore catalog will tell you how to get Engineering help. Mail the coupon.

DUMORE MOTORS

MAIL THIS COUPON FOR YOUR COPY

The Dumore Co.
Dept. 126F, Racine, Wis.

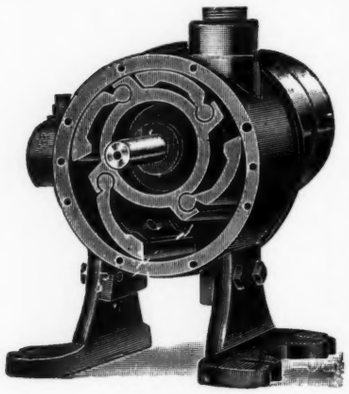
Send your motor catalog and engineering service application.

Name.....

Address.....

City..... State.....

QUIET, POWERFUL and EFFICIENT
LEIMAN BROS. PATENT ROTARY POSITIVE
AIR PUMPS
USED BY THE WORLD'S LEADERS AS STANDARD EQUIPMENT ON ALL SORTS OF AUTOMATIC MACHINES AND DEVICES
MANY SIZES and STYLES



TAKE UP THEIR OWN WEAR
No packing or tips on the wings

The built-in one-year-lubrication of Leiman Bros. Rotary Positive Air Pumps is the new wool yarn packed bearing which holds in suspension enough lubricating oil for one year's service — strained and purified.

The continuous unbroken cylinder surface makes these always noiseless air and gas pumps doubly quiet. The air enters and emerges in a sidewise course through the bypass in the cylinder head side.

This means a smooth, glassy-like cylinder surface, easy operation and saving in power.

The advantage gained by this simple construction is that the wings in constant operation will wear in conformity with the inner cylinder wall and become smooth and glassy like as well as case hardened in use, and maintain a perfect fit and positive air pressure, even after long continued usage.

LEIMAN BROS., INC.
177 (6) Christie St., Newark, N. J.
LEIMAN BROS., N. Y. Corp., 23 (P6) Walker St., New York City
Makers of good machinery for over 45 years

The Stellarscope, molded for the University of Chicago, is a valuable adjunct to Prof. Walter Bartky's "Highlights of Astronomy". In this plastic molded "pocket planetarium", illuminated pictures of the constellations appear in actual size, providing exact identification.

Most scientific instruments can utilize to advantage the durability, uniform exactness, and insulating qualities of molded plastics. You are invited to consult us about your molding problems.

CHICAGO MOLDED PRODUCTS
CORPORATION
2147 Walnut Street *Chicago, Ill.*

formly flat surface yet allow the free passage of air through them.

COUPLINGS—John Waldron Corp., New Brunswick, N. J., has issued an attractive catalog which fully describes and illustrates new gear type flexible couplings. Included in the book are the medium duty type, torque ring type, floating shaft types and full diagrams and ratings for each.

DRIVES—Complete details on the company's line of motorized speed reducers are presented in a recent folder, bulletin 22-5, of Janette Mfg. Co., 556 West Monroe street, Chicago.

DRIVES—A complete picturization of the many types of infinitely variable speed units built by Reeves Pulley Co., Columbus, Ind., and the field of each of these units is included in a recent folder prepared by the company.

DRIVES—A presentation of the company's entire line of infinitely variable speed transmissions is presented in catalog 25-D of Lewellen Mfg. Co., Columbus, O. Controls available, details of operation, and typical applications are covered.

DRIVES—Complete engineering data on many types of speed reducers, including a patented motorized design, are included in the new 128-page data book of Foote Gear Works Inc., 1301-G South Cicero avenue, Chicago, Ill. The motorized type is so built that the disassembly of the motor from the reducer is possible without disturbing or detaching the reducer proper.

ELECTRONIC EQUIPMENT—The many and improved electronic tubes which permit wider industrial application are covered in new data sheets covering tube ratings and characteristics prepared by Westinghouse Lamp Co., Bloomfield, N. J. Amplifier and oscillating tubes; grid glow tubes and ingitrons; phototubes; rectifier tubes and miscellaneous types are discussed.

FASTENINGS—A new time-saving slide rule which automatically calculates weight per thousand pieces or pieces per pound of any size washer in any material including steel, brass, copper, aluminum, fiber, paper, etc., has just been developed by Wrought Washer Mfg. Co., 2102 Bay street, Milwaukee.

FORGINGS—Information on drop forgings arranged in the form and shape of a standard letter-size filing folder, and containing much useful information including a table of weights of metals, die draft equivalents and practical data and explanation of accepted drop-forging practice is being distributed by J. H. Williams & Co., 420 Vulcan street, Buffalo, N. Y.

HYDRAULIC EQUIPMENT—Remote control units, for use with hydraulic power equipment, which eliminate the need for mechanical control devices are described in bulletin 44101 of Oilgear Co., 1319 West Bruce street, Milwaukee.

INSTRUMENTS—Brown Instrument Co., Philadelphia, has prepared a bulletin which illustrates and describes the part instruments and controls play in the modern industrial plant.

MOTORS—"Facts for Users of A. C. Motors" is the title of a new bulletin of Lincoln Electric Co., Dept. C-249, Cleveland, which includes complete details on the line of

squirrel cage induction motors manufactured by the company.

MOTORS—Reliance Electric & Engineering Co., 1050 Ivanhoe road, Cleveland, has issued bulletins 215 and 216 on its line of 6-pole heavy duty motors for direct current, 40 degrees Cent. rating. Details of construction of the motors are given.

OPTICAL PARTS—Lenses, prisms, mirrors and other optical parts manufactured by Bausch & Lomb Optical Co., Rochester, N. Y., are attractively presented in catalog D-10 of the company which enables the selection of these parts for any individual application encountered.

PIPE—The fourth edition of "Toncan Iron Pipe for Permanence" is being distributed by Republic Steel Corp., Cleveland. This new 64-page book is profusely illustrated with test charts and tables and incorporates new sections dealing with threading, air conditioning, industrial maintenance and process uses, and brewing and distillation applications.

PULLEYS—Dings Magnetic Separator Co., Milwaukee, has prepared catalog No. 25 on its line of magnetic pulleys which may be built into the machine. These pulleys will remove all iron from any material being conveyed along a belt.

PUMPS — Ingersoll-Rand Co., Phillipsburg, N. J., has prepared a new bulletin describing the Cameron Motorpump as used in air conditioning service.

TRANSMISSION EQUIPMENT—Book No. 1500 of Link-Belt Co., Chicago, gives detailed information, tabular data, and applications of the company's line of pillow blocks, clutches, collars, couplings, gears, hangers, pulleys, shafting, take-ups and grease cups. All information needed for the application of the parts is included.

TUBING—A comprehensive review of many types of seamless tubing suitable for use in a wide variety of machine applications is given in bulletin No. 41 of Parker Appliance Co., 17325 Euclid avenue, Cleveland.

WELDED PARTS AND EQUIPMENT—The latest information on the welding and cutting of high chromium steels is completely given in a recent booklet of Linde Air Products Co., 205 East Forty-second street, New York. The effect of chromium on welding procedures is discussed.

Research Publications

Second Report of the Welding Research Committee. A considerable number of welds were prepared by firms carrying out welding operations to specifications drawn up by this committee of the Institution of Mechanical Engineers, England. Tests of these were carried out in the condition as welded and after two heat treatments. A number of welds were submitted to X-ray examination. Included in the wide range of physical tests carried out were: Tensile tests and impact tests at various temperatures; repeated stress tests; bend tests; investigation of hardness distributions and corrosion tests. Published by Institution of Mechanical Engineers, London, England, 94 pp.

MACHINES*

of all types are designed by Executives and Engineers who read Machine Design

Adding machines
Addressing and mailing machines
Agricultural machinery
Aircraft
Bakers' machinery
Baling presses
Blowers and fans
Bookbinding machinery
Bottling machinery
Calculating machines
Canning machinery
Card-punching and tabulating machines
Cars and trucks
Cash registers
Cement and concrete machinery
Change making machines
Check writing machines
Clay working machinery
Clothes pressing machines
Coffee roasting and grinding machines
Condensers
Confectionery and ice cream machinery
Conveying machinery
Cotton gins
Cranes, including hoists and derricks
Dairy machinery
Dish washing machinery
Dredging and excavating machinery
Electrical machinery
Elevators and elevator machinery
Engines, steam and internal combustion
Fare registers and boxes
Flour mill and grain mill machinery
Foundry machinery
Gas machines
Gas regulators
Glass making machinery
Hat-making machinery
Hydraulic machinery
Incandescent lamp making machinery
Laundry machinery
Lawn mowers
Leather working machinery
Locomotives
Machine tools
Manifolding machines
Metal working machinery
Meters, gas and water
Mining machinery
Miscellaneous and special machinery
Motion picture cameras and projector
Motorcycles and bicycles
Motor vehicles
Oil-mill machinery
Oil-well machinery
Ore crushers
Packaging machines
Packing house machinery
Paint making machinery
Paper box machinery
Paper mill and pulp mill machinery
Pharmaceutical machinery
Photo-engraving machinery
Pneumatic machinery
Printing machinery
Pumps and pumping machinery
Refrigerating and ice making machinery
Road making machinery
Rolling mill machinery
Rubber working machinery
Scales and balances
Sewing machines
Shoe machinery
Slicing machines
Slot vending machines
Stokers, mechanical
Stone working machinery
Sugar mill machinery
Textile machinery
Tobacco manufacturing machinery
Transmission machinery
Typewriters
Vacuum cleaners
Washing machines, ironing machines
Welding machines
Well-drilling machinery
Windmills and towers
Woodworking machinery

***Machines as classified by the United States Census Bureau**

Business and Sales Briefs . . . . . .

AMERICAN ENGINEERING CO., Philadelphia, manufacturer of hydraulic pumps, motors and transmission, has appointed John F. Cooke to have charge of the sales of the pump and other divisions. The New York sales office of the company have been removed to larger quarters in the Evening Post building, 75 West street.

* * *

The Chicago sales engineering office of New Departure Mfg. Co., makers of ball bearings and variable speed drives, has been moved to 230 North Michigan avenue.

* * *

Cumberland Steel Co., Cumberland, Md., Manufacturer of turned and ground steel shafts, has appointed A. C. Cook as district sales manager to cover New York city, Long Island, Northern New Jersey and Eastern New York state.

* * *

The New York district sales office of Republic Steel Corp. has opened a new sub office in the State Bank building, Albany, N. Y., with J. M. Higinbotham, salesman in charge. L. L. Caskey has been appointed district sales manager for the Republic company in the Philadelphia territory. J. B. DeWolfe, whom Mr. Caskey succeeds, has been transferred to the general offices in Cleveland to assist George E. Totten, manager of sales of the tin plate division. J. W. Braffett, for the past seven years Detroit representative of Oliver Iron and Steel Corp., has joined the Detroit sales staff of Republic Steel Corp., Upson Nut division, located in the Fisher building.

* * *

Allegheny Steel Co., Brackenridge, Pa., has reopened its office in Cleveland, located at 1621 Euclid avenue.

* * *

Ex-Cell-O Aircraft & Tool Corp., 1200 Oakman boulevard, Detroit, has appointed A. D. Heath, 1701 North Illinois street, Indianapolis, as exclusive representative in the Southern Indiana territory.

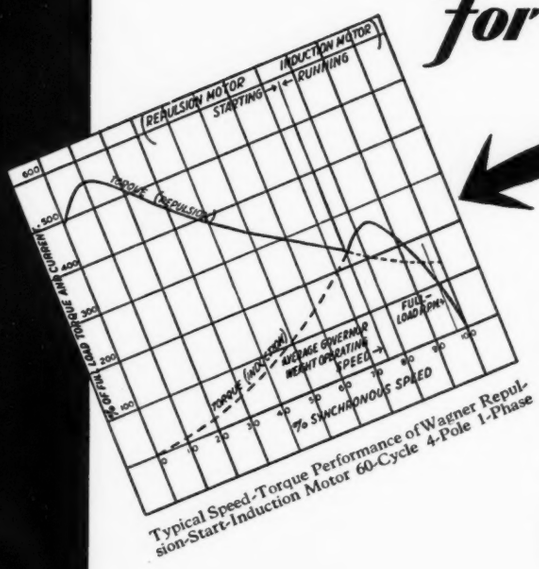
* * *

Link-Belt Co., Chicago, has appointed Industrial Supplies Inc., Poplar avenue and River Front, Memphis, Tenn., as authorized stock-carrying distributor of its line of elevating, conveying and power transmitting chains and machinery; antifriction bearing units; and complete silent and roller chain drives.

* * *

Lincoln Electric Co., Cleveland, has announced the following changes and promotions in its sales personnel: J. S. McKeighan has been transferred to the sales staff and is stationed at 1712 Catalpa drive, Dayton, O., operating under the Cincinnati district office at Fifth and Baymiller streets; J. B. McCormick has been transferred from the Philadelphia office, 401 North Broad street, to the Pacific Coast, and is located at 3160 Montecito ave-

Good MOTOR PERFORMANCE is Essential For Satisfactory Operation



Typical Speed-Torque Performance of Wagner Repulsion-Start-Induction Motor 60-Cycle 4-Pole 1-Phase

Examine the performance curves of WAGNER MOTORS and see why they will give satisfactory service on your job.

On examination of the typical speed-torque curves of a Wagner repulsion-start-induction type "A" motor shown at the left, you will see why these motors will stand up under heavy load conditions. These curves represent approximately the average performance of Wagner repulsion-start-induction motors. By following the solid line it will be noted that the starting torque exceeds five times full-load torque and at approximately 82% full-load speed the torque is 2½ times full-load torque. These high-torque characteristics of Wagner repulsion-start-induction motors make them particularly desirable for machinery with severe starting and running requirements.

Performance is but one of the important qualities to consider in the selection of motors. Such factors as dependability, quietness, interchangeability, and careful design are equally important requisites. These considerations and all the other details you may want to know about Wagner small motors are completely described in Wagner Small Motor Bulletin 177. Write for this bulletin.

MS 336-3J

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, U.S.A.

MOTORS • TRANSFORMERS • FANS • BRAKES

nue, Fresno, Calif., under the personnel of the Los Angeles office at 812 Mateo street; Paul W. James has been transferred from the factory to 16½ Crandall street, Binghamton, N. Y., operating under the Syracuse office at 517 Erie Boulevard, East; Major Engineering Works has moved its offices from 210 Jackson avenue to larger quarters at 312 Second street, Des Moines, Ia.

* * *

Chain Belt Co., Milwaukee, has moved its Pittsburgh office to room 526 Grant building. G. E. Mahoney, formerly a sales engineer in the Milwaukee offices of the company, will be located in the Pittsburgh office.

* * *

William McBride has been appointed vice president in charge of sales of Pittsburgh Steel Foundry Co., Glassport, Pa.

* * *

Julius Kahn, who has been president since his founding of Truscon Steel Corp. thirty-three years ago, has resigned his position to become vice-president in charge of product development of the Republic company.

* * *

Otis Steel Co., Cleveland, has opened an eastern district sales office in the Chrysler building, New York. E. A. Steif, who for many years has represented the company as manufacturer's agent in the East, has been appointed manager of sales for the New York district.

* * *

Union Drawn Steel Co., Massillon, O., has moved its Dayton office to larger and more suitable quarters at 621 Mutual Home building in order to provide better service to steel users in Southwestern Ohio. Ralph Hering, who has served in the Dayton territory for the past four years, will be in charge of the new office.

* * *

Bantam Ball Bearing Co., manufacturer of ball and roller bearings, is adding new machinery and building an addition to its plant at South Bend, Ind., at a cost of $250,000. This new expansion gives an additional area slightly greater than the addition which was built last year which gave the factory a 60 per cent increase in floor space.

* * *

Jansen-Byrd Co., Spokane, Wash., has been appointed distributor of Enduro stainless steel by Republic Steel Corp., Cleveland. The Cameron & Barkley Co., with warehouses at Jacksonville and Miami, Florida, will distribute a complete line of Republic tubular products including lap, butt and electric weld steel and copper bearing pipe, and copper molybdenum electric weld pipe.

* * *

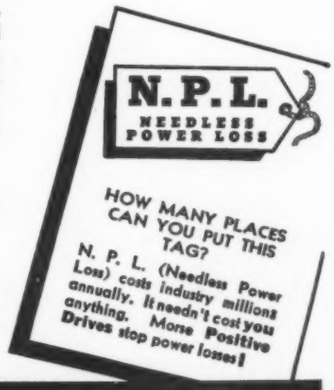
Inland Steel Co., Chicago, has announced the appointment of Joseph L. Block as executive vice president in charge of sales and Albert C. Roeth as vice president and general manager of sales. Mr. Block, associated with the Inland company since 1922, and a director since 1930, has been in charge of the sale of bars and semi-finished steel. Mr. Roeth has been in charge of the sales of structural shapes, plates and sheet piling.

Morse Roller Chains
LAST LONGER

MORSE Positive Drive Roller Chains offer the newest and finest development in roller chain design. Especially recommended for extreme conditions where other chains have failed. Exclusive lubrication feature permits oil to reach inside of joint easily and to be retained in adequate amounts. Many other important features such as heat-treated, alloy steel, precision-ground **solid** rollers, and cold-drawn, nickel steel pins and bushings, **carburized and hardened** for maximum wear resistance. ⅜" to 2½" pitch, in single and multiple widths.

For complete information, call local Morse office, or write factory.

MORSE CHAIN CO.
Division of Borg-Warner Corporation
ITHACA • NEW YORK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NEEDLESS POWER LOSS
HOW MANY PLACES CAN YOU PUT THIS TAG?
N. P. L. (Needless Power Loss) costs industry millions annually. It needn't cost you anything. Morse Positive Drives stop power losses!

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SILENT CHAIN and ROLLER CHAIN DRIVES • COUPLINGS • CLUTCHES

High speed vibrating screen—Treadwell Engineering Co.

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Here where correct adjustment is most vital to operation and the life of equipment—in the eccentric straps and roller bearing housing—Treadwell provides Laminum shims. By simply p-e-e-l-i-n-g one or more laminations from the brass shim you obtain correct operating adjustments . . . quickly. Lower maintenance cost . . . long shutdowns avoided. Write for a sample of Laminum.

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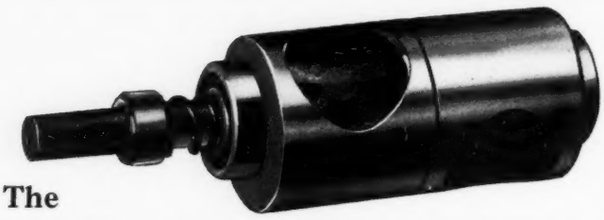
580



The
SOURCE of ROTAPISTON'S
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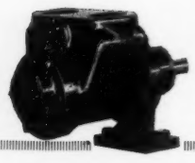
NOTE the two reciprocating, cylindrical pistons at right angles to one another — each double acting (making four cylinders)—affording continuous flow. Both rotor and piston operate at one-half the speed of the camshaft . . . a positive mechanical 2-to-1 movement without gears.

Three standard sizes are built to interchange with other makes of pumps. Four other models available with special mountings. Capacities range from ⅛ to 324 gallons per minute. Larger capacities on special order . . . May we mail complete data in folder form?



THE GLOBE PRODUCTS CO.
4008 E. 89th St. Cleveland, O.

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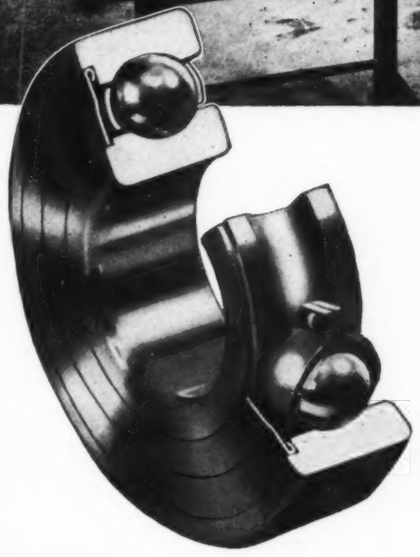
The **BEARINGS**, *too, must be designed for*



EACH one of this battery of five Landis Automatic Forming and Threading Machines is turning out from 750 to 1800 threaded bolts an hour. One operator handles the battery. That means that each machine must function perfectly, day-in and day-out, with little or no attention except the time for setting-up, and loading hoppers. BCA Ball Bearings are used exclusively in these Landis machines.

The use of BCA Ball Bearings in the machine tool industry, and in the finer motor cars, trucks and tractors, is indicative of the high standards of quality maintained in their manufacture.

BCA Annular Bearings are made in single and double-row, with shields and felt seals, if desired. Ask about the new BCA Thrust and Angular Contact Bearings.

BEARINGS COMPANY OF AMERICA
517 HARRISBURG AVE., LANCASTER, PA.

A DATA BOOK
for Engineers and Draftsmen

A new, complete and more convenient Ball Bearing Data Book

The man at the drafting board will welcome this new and more convenient Ball Bearing Data Book. Complete information on all types with load ratings. New, simplified method of figuring loads at any desired speed. Lies flat on drawing board. Write for a copy today.

Court Aids Machinery Sales

LOOK for following consequences of the Supreme Court's decision that washed up the Guffey coal act:

1: Bankruptcies of weak mining properties where creditors have carried companies along in the wait for the decision.

2: Revival of the Appalachian Coals, Northern Coals and other regional selling companies that functioned for a time just before the NRA. The court has o. k.'d them. Appalachian members met in Cincinnati recently.

3: Purchases of coal mining machinery by the stronger companies, perhaps a boom in the mechanization of mining in both the northern and southern fields.

A DECISION like the one yesterday is bound to sharpen competition and intensify the effort to lower costs. Wage cuts would lead to strikes, and producers would prefer to cut their costs by installing machinery. This will bring on the same increase in employment around the plants that make the machinery and the same reduction in employment around the mines which all "labor-saving" machinery causes, but it may be that this unemployment will be more persistent than that which occurs in other industries.

No one denies, so far as I know, that machinery frequently causes at least temporary unemployment in the places where it is installed—the argument is always over the question of how nearly permanent it is. In coal mining it is likely to be longer than in industries where the men have access to other kinds of work, including the work of making and servicing the machinery. Coal miners notoriously stick around the mines, and the mines are usually remote from other jobs.

We may conclude that some of the 30,000 Ohio miners had better get out of mining towns as soon as they can.

COAL has been cut by machines for years, though amongst Ohio's 5000 mines (including the "gopher holes") there is still a good deal of pick mining. The mechanization next in order is the mechanical loader, the device that picks up the coal where it has fallen and puts it into mine cars for transport to the mine mouth. The machine may be 20 feet long and only four feet high, jointed a couple of places like a prehistoric saurian—the comparison is Whitney Warner's: he saw the dinosaurs at the Century of Progress and thought of coal loaders.

These machines are made in Cincinnati, Columbus, Knoxville and a couple of other places. The Joy plant in Franklin, Pa., is said to be turning out 25 or more of them a month, at $8000 to $12,000 apiece, all of them using motors made at the Reliance Electric & Manufacturing Co. in Cleveland, the company of which Clarence Collens is president. Mr. Collens was a diligent NRAer in the electrical industry but his company benefits from the breakdown of regulation in coal. Electric Controller would be another Cleveland concern that would get business from mechanization in mining.

A COAL miner who loads coal onto mine cars at the working face in a mine does not load rock, if he's a good miner, but the mechanical loader picks up everything, like the much overplayed mechanical cotton picker. So if you are going to have loaders in Ohio you ought to have a cleaner, and that really takes the dough. A complete outfit will cost from $50,000 on up, and a mine of 5000 tons daily capacity will cost $500,000 to $750,000 to mechanize.

◆

The accompanying article has been abstracted from a column entitled "Today's Business," by John W. Love, a writer who frequently treats machinery matters in The Cleveland Press.

◆